SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

NOVEMBER 1902.

GENERAL PHYSICS.

1985. *The Gravitation Constant.* **G. K. Burgess.** (Phys. Rev. 14. pp. 257–264, May–June, 1902.)—The author summarises the experimental results for the earth's mean density, and deduces the most probable value by the method of least squares. The result is for the earth's mean density $5{\cdot}5247 \pm 0{\cdot}0013$. The corresponding value of the absolute gravitation constant is $(666{\cdot}07 \pm 0{\cdot}16) \times 10^{-10}$. It would seem desirable to make a new experimental determination of the density by Wilsing's method. W. S.

1986. *Measurement of Minute Masses.* **E. Salvioni.** (N. Cimento, 3. pp. 386–389, May, 1902.)—The author has devised and accurately examined a microbalance, which consists of a thin thread or very thin ribbon of glass or other material, fixed at one end and placed in a closed case; the case also contains a number of small weights (the larger of platinum wire, the smaller of silk thread), which, with the aid of a handle, can be placed on the flexible thread or ribbon. The flexure of the thread when loaded is observed by means of an ocular micrometer, and, as verified by the author for his instrument, is proportional to the weight which produces it; a conveniently placed spider thread serves as a sight-line for the measurement of the displacements. A glass thread 10 cm. long, and one to two-tenths of a millimetre in diameter will support by flexure a weight of more than 100 mgr., and, if provided with an optical arrangement which magnifies one hundred times, will serve to weigh to one-thousandth of a milligram. To avoid the inconvenience caused by subsequent elasticity, the balance is provided with an arrestment which enables the flexure to be maintained after unloading. The author finds that the loss of weight of musk by volatilisation is clearly demonstrated by this instrument. The loss is proportional to the time. D. H. J.

1987. *Stability of a Thin Hollow Cylinder of Revolution acting as a Strut.* **A. Gros.** (Comptes Rendus, 134. pp. 1041–1043, May 5, 1902.)—The question considered is the following: Given a hollow cylinder of thickness t, small compared to the radius r, subject to given longitudinal thrust uniformly distributed, to determine the minimum thickness in order that the cylinder may completely regain its original form after strain. The author divides the cylinder into prismatic elements by means of very close meridian planes, and supposes a deformation such that the solid remains a solid of revolution. Then by symmetry every prismatic element is in the same condition. Hence if we neglect transversal elasticity, *i.e.*, suppose the cylinder formed by mere juxtaposition of the elementary prisms, Euler's formula for a long rod with ends free reduces to $p = \pi^2Et^3/48l^2$, where $2l$ is the length of the cylinder, E its modulus of elasticity parallel to the generators, and p the thrust per unit length of the circumference. This condition ensures the elastic equilibrium of each elementary prism supposed isolated, and *a fortiori* that of the real cylinder in which they are connected. The condition is therefore *sufficient, but not necessary* for elastic equilibrium of the cylinder with ends free. By considering the transversal elasticity E′, and using the elementary theory of plane flexure, the author finds for the stability of the elementary prisms, and consequently of the whole cylinder, the *sufficient but not necessary* condition $p = t^2\sqrt{EE'}/r\sqrt{3}$. He thus finds two completely independent conditions, either of which ensures stability. In practice of course a factor of safety must be adopted, and in view of the small thickness the value of t should be modified, *e.g.*, in calculating the greatest load for a given thickness it is prudent to substitute a quantity $t - t'$ for t. The modification of the formulæ to suit the case of constrained ends is obvious. W. S.

1988. *Thin Floating Cylinders.* **T. Alexander.** (Nature, 66. pp. 6–7, May 1, 1902.)—The author pointed out [see Nature, 55. p. 366, 1897] that a thin cylindrical floating shell is in equilibrium under the actions of its own weight and the external fluid load, the shell having its axis horizontal, and just touching the surface or else completely submerged. He now shows that "polygonal cylinders of uniform plates freely hinged at their edges and displacing their own weight of fluid and lying horizontally are also in equilibrium, provided the polygon be regular." The ends are supposed closed by smooth plates having the same density as the fluid; they exclude the fluid but allow free motion of the hinged sides. W. S.

1989. *Elasticity and Viscosity of Ice.* **H. Hess.** (Ann. d. Physik, 8. 2, pp. 405–431, May, 1902.)—The author investigates the viscosity of ice by observing the rate of deformation of rods of the substance loaded in the centre, and studies the mode of its dependence on the kind of ice, the magnitude of the force acting, its direction with respect to the crystalline axis, and the time. In all cases if the force be constant the viscosity decreases with the time; for the relation of the viscosity to the other quantities involved reference must be made to the original paper. With a view to the bearing of the matter on glacier motion, he investigated a mixture of ice and rough particles of sand, cemented together by allowing the interstices to fill with water and then freezing; for such a mixture the viscosity is, *ceteris paribus*, about ten times as great as for pure ice. He used also a mixture composed of compressed ice, dust, snow, and other substances in layers. For the Young's modulus he finds for all kinds of ice the value $2{\cdot}76 \times 10^{10}$ c.g.s., which agrees with Reusch's value obtained by a different method. The author has also experimented on the velocity of efflux of ice from a cylinder when subjected to pressure; he finds an increase in the velocity with the time, the pressure being constant. Finally he considers his results with reference to glacier motion. W. S.

1990. *Compressible Viscous Fluids.* **P. Duhem.** (Comptes Rendus, 134. pp. 1088–1090, May 12, 1902.)—The author defines a fluid as a body, each element of which is in a state completely defined by the temperature T and a single normal variable, the density ρ. Hence within the fluid the virtual work of viscosity (*dv* denoting the element of volume) is—

$$d\bar{\mathfrak{T}}w=\int f(\rho,\mathrm{T})\frac{d\rho}{dt}\cdot\delta\rho dv.$$

For an incompressible fluid this is identically zero, whence *if a body is rigorously fluid and rigorously incompressible, it must be considered devoid of viscosity.* All viscous fluids are compressible, and the properties of such fluids are derived from the above equation. The author shows that the equations of motion of a viscous fluid are the same as the ordinary Eulerian equations, with the "fictive" pressure P substituted for the actual pressure Π; but the equation of compression and dilatation, which was $\Pi \leftarrow \rho^2\frac{\partial\zeta(\rho,\mathrm{T})}{d\rho}=0$, becomes—

$$\mathrm{P}-\rho^2\frac{\partial\zeta(\rho,\mathrm{T})}{d\rho}-\frac{\lambda(\rho,\mathrm{T})}{\rho}\frac{d\rho}{dt}=0;$$

thus the laws of motion of a viscous fluid differ from those of a non-viscous only in that *there is no longer a relation in finite terms between the pressure, temperature, and density, such relation bring replaced by a differential equation giving* $d\rho/dt$ *in terms of* ρ, *T, P.* He points out also that for a compressible perfect fluid, at a point where the pressure and temperature are P and T, the density ρ has the same value ρ_0 as if the fluid were in equilibrium under that pressure and at that temperature; while for a viscous fluid in motion ρ at each point varies in such a sense as to approach ρ_0. In a *slightly* viscous fluid, where the velocity varies but little from point to point, ρ is very nearly equal to ρ_0, and so we see how a perfect fluid is the limiting form of a fluid slightly viscous.

W. S.

1991. *Viscosity in the Neighbourhood of the Critical State.* **P. Duhem.** (Comptes Rendus, 134. pp. 1272–1274, June 2, 1902.)—The author extends his former considerations on compressible viscous fluids [see preceding Abstract] to the case in which the fluid is near the critical state. At every point of the fluid and at every instant the temperature T and density ρ are supposed to have approximately their critical values. It is shown that while the density differs by a finite amount from ρ_0, the equilibrium value under the "fictive" pressure and at temperature T, the density of an element may vary very slowly; in such a state the fluid is in quasi-equilibrium, and the component velocities are very small at every point and at every instant; such a state is not permanent, the density at each point varying very slowly till it attains the value ρ_0. It is possible also to observe the fluid in such a state that it has sensible motion; if the accelerations are very large the rate of variation of density is no longer very small. In this way we may take account of the effect produced by the motion of a stirrer in a fluid near its critical state. If the accelerations are small the density of any material element varies very slowly, and the problem is mathematically the same as that of a dissolved substance diffusing slowly through the solvent; hence the similarity of the striæ in a fluid near the critical point to the motions in a solution having great differences of concentration at different points. W. S.

1992. *Diffusion of Two Portions of a Homogeneous Fluid into each other.* **K. Stanzel.** (Akad. Wiss. Wien, Sitz-Ber. 110. 2a. pp. 1038–1052, 1901.

From the Physikalisch-chem. Instit. Universität, Wien.)—The chance that a molecule initially at the origin of co-ordinates has at time t its x-co-ordinate between x and $x + dx$ is found to be $(A/\pi t)^{\frac{1}{2}} exp(-x^2A/t)$, where A is a magnitude depending on the constitution of the substance, being of the form Kns^2/c for a simple cohesionless gas, but of much more complicated form in other cases. Here K is constant for all gases and the other letters bear their usual signification. The number of molecules which pass in time t from one half of a cylindrical vessel of length L into the other is then found to be—

$$n(A/\pi t)^{\frac{1}{2}}\int_0^{\frac{1}{2}L} du \sum_{i=-\infty}^{i=+\infty} \int_{u+2iL}^{u+(2i+1)L} dx\, exp(-x^2A/t).$$

Comparison of von Obermayer's experimental results for the inter-diffusion of NO_2 and CO_2 (which have the same molecular weight) and of other gases with the results of the above calculation shows slight discrepancies, which may be explained by taking into account the cohesive forces which actually come into play or by assuming the dependence of s upon temperature. R. E. B.

1993. *On Some Problems of Elastic Equilibrium.* **O. Tedone.** (Accad. Lincei, Atti, 10. pp. 294–296, Dec. 15, 1901.)—This is a continuation of an earlier memoir [see Abstract No. 433 (1902)]. Using the notation of the preceding memoir he now gives, as a generalisation following immediately from the results there obtained, a solution of the problem of the determination of the elastic deformation of an isotropic homogeneous medium bounded by the faces of a rectangular triedron, when the displacements are given at every point on the surface. He points out that the method is also applicable to the case of a medium bounded by two planes at an angle commensurable with π—or by three planes forming a birectangular triedron, the third angle, which is not a right angle, being commensurable with π. The method also leads to a solution for the case where, instead of the superficial displacements, the superficial tensions are given. S. H. B.

1994. *Recording Beginning and End of Light Precipitation.* **O. L. Fassig.** (U.S. Weather Bureau, Bull. 31. pp. 213–214; Discussion, p. 214, 1902.)—A sheet of paper, on which fine lines are drawn in copying ink, having been used to catch the few drops of very small showers, it occurred to the author to place such sheets on a revolving drum so as to obtain time records in a simple, inexpensive way. **Oberholzer** remarked that he tried other devices for the same purpose, making the drops, *e.g.*, close an electric circuit; he also referred to improvements of the tilting buckets, which were clogged by the dust and smoke, and did not tip fast enough in very heavy showers. H. B.

1995. *Air Movement and Atmospheric Pressure.* **J. W. Sandström.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. 3. pp. 87–104, March, 1902.)—From his previous researches upon the relation between temperature and movement of the atmosphere under stationary conditions, the author deduces the following rules for the distribution of the atmospheric pressure: (1) If the skies move more rapidly than the wind at the surface of the earth, to an observer placed in the direction of their movement the vertical distances of the isobaric surfaces will be greater at the right than at the left; (2) in the opposite case, these distances will be greater at the left than at the right; (3) on the hypothesis (1), the same distances in cyclones will be smaller in the centre than at the edges, and *vice versâ* for anti-cyclones; the opposite taking place on hypothesis (2). These results having been given an analytical form, the author goes on to verify them by the outcome of the Berlin scientific aerostatical excursions. They are next applied to determine the reciprocal inclination of isobaric surfaces and the distribution of temperature in the neighbourhood of a meteorological station. The influence of moisture on the thus calculated quantities is finally pointed out. A. G.

1996. *Chinook Winds.* **E. J. Glass.** (U.S. Weather Bureau, Bull. 31. pp. 41–42; Discussion, p. 48, 1902.)—The westerly warm Chinook winds of the eastern slope of the Rocky Mountains are welcome, as they drive the snow from the peaks into the ravines, where it cakes, preventing destructive thaws. At Helena, Montana, which is situated in a gulch, temperatures of — 30° F. have been observed, whilst the thermometer was above zero at Unionville, 6 miles to the north, a few hundred feet higher up at the head of the gulch. The winds are accompanied by extraordinarily rapid rises of 40 and 50°; during the first hour of a Chinook, rises and falls of 20° may alternate within five minutes. Two photographs are given, showing ragged cumulus clouds travelling eastward at great speed over an exceptionally clear sky. According to **Clayton**, the Chinooks are not unknown in other parts of the United States. H. B.

1997. *Recording the Motions of the Atmosphere.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 80–87, Feb., 1902.)—The author advocates uniform methods, recommending the metric system, the universal use of certain symbols, and right-hand counter-clockwise rotation giving the azimuth of the point towards which the wind is blowing, this azimuth to be reckoned from south through east to north. In his rectangular or cylindrical co-ordinates, $+x$ refers to southward and radially outward motion; $+y$ to eastward and tangential counter-clockwise motion; $+z$ to zenithward and upward motion. He then explains his method of computing the resultant direction and velocity of air motion from observations extending over large areas. H. B.

1998. *Relation between General and Local Forecasts.* **F. J. Walz.** (U.S. Weather Bureau, Bull. 31. pp. 117–125; Discussion, pp. 125–127, 1902.)—The author discusses the difficulties of the general and local forecasts of the U.S. Weather Bureau with especial reference to the verification of forecasts as practised at the Central Office and at Chicago, where the author is stationed. The verification slips of H. J. Cox, in use at Chicago, distinguish between positive failures—weathers predicted which did not come—and negative failures—features which were not predicted.—**E. H. Bowie** recommended the author's suggestions; forecasts of probable minimum temperature are often asked for by dealers in perishable goods. H. B.

1999. *Warm Air Currents at High Altitudes.* **R. Assmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 24. pp. 495–504, May 1, 1902.)—When a balloon floats in the atmosphere, the ventilation of the aspiration thermometer fails, and solar radiation prevails; this accounts for the rises of up to 30°, registered in the higher atmosphere by the instruments of some of Hermite and Besançon's unmanned balloons. In order to prevent this floating and mere drifting, Assmann proposed to try small perfectly closed balloons, made of rubber, which will rise under continued expansion until they burst; the subsequent fall is checked by a parachute. The author discusses the records obtained with such balloons on six occasions in 1901, when heights of 18 km. and even, on July 30, of 17 km. were reached with balloons from 1 to 2 m. in diameter. On July 30, Berson and Süring also ascended to 11,000 m., but they were unconscious at the extreme elevation. Five or six atmospheric strata of different temperatures were observed; the temperature gradient per 100 m. ranged from — 1·46° through 0° to + 0·24°; in the stratum between 12·5 and 16 km. the temperature rose, on July 30, from — 54 to — 49°, then to fall again slowly. There was always a temperature inversion at altitudes between 10 and 15 km. These observations agree with those of Teisserenc de Bort [see Abstracts Nos. 644 and 1667 (1902)], who sends up paper balloons, however, of about 50 c.m. capacity. H. B.

2000. *Sky Polarisation and Weather Conditions.* **L. G. Schultz.** (U.S. Weather Bureau, Bull. 31. pp. 28–31; Discussion, p. 31, 1902.)—Having drawn attention to Dorsey's *résumé* on the blue colour of the sky [see Abstract No. 367 (1901)], the author briefly describes experiments conducted during the last three years at Walla Walla, Spokane, Kalispell, and Fort Worth on the polarisation of the sky with apparatus of the type formerly used by Pickering. Each of these stations has its own characteristic polarisation curves. Noon observations are difficult on account of cloudiness and topographical features. The polarisation is generally greater and more regular in the morning than in the evening; irregularities in the polarisation at sunrise are more frequently followed by atmospheric disturbances than those at sunset. High polarisation indicates settled weather; low polarisation cloudiness, the clouds appearing in that portion of the sky where the polarisation was weakest. The polarisation is a valuable indicator of otherwise invisible changes in clouds; when clouds are dissolving, the polarisation increases. The polarisation is weak in showery weather, strong in fair weather, though the sky may be covered with heavy cumulus clouds.—**Abbe** and **Moore** dwelt on the importance of these studies since the connection between polarisation and weather has often been denied. H. B.

2001. *May Temperature Curve for Baltimore.* **O. L. Fassig.** (U.S. Weather Bureau, Bull. 31. pp. 68–69, 1902.)—While there is some basis for the popular belief in a cold wave for the days May 11–13 in Central Europe, the author finds that the temperature curves of Baltimore for the thirty years 1871–1900 show a well-defined rise for the days May 9–12. The thermometer rises during that period about 4° above the average of the days May 8–13. H. B.

2002. *Eclipse Meteorology.* **F. H. Bigelow.** (U.S. Weather Bureau, Bull. 1. pp. 13–166, 1902.)—This volume contains the reports of observers at American stations during the total solar eclipse of May 29, 1900. Summary tables are provided to show the mean variations of pressure, temperature, vapour pressure, wind velocity, cloudiness, &c. In the instrumental section the author concludes that a short focus lens with secondary magnifier is preferable to the long focus objective used to give direct image. Interesting details are given of appliances for erection of instruments not provided with observatory refinements. The effects of the passage of the moon's shadow on the various meteorological elements were observed at sixty-two stations, which were so distributed along the path of totality that the eclipse effect could be differentiated from the ordinary diurnal changes. Generally speaking there appears to have been a lowering of temperature of about

4° or 5° F., a lowering of the vapour pressure by 0·007 in., and a decrease in wind velocity of about 1 mile an hour.

Considerable discussion is given of the form presented by the photographs of the corona obtained in relation to the predicted features based on the electromagnetic theory of the solar surroundings which is put forward by the author. C. P. B.

2003. *Altitude Observations at Sea.* **J. Joly.** (Roy. Dublin Soc., Proc. 9. pp. 559–567, May, 1902.)—The paper describes a simple method of observing the altitude of a celestial object at sea at night-time or when the horizon is obscured. A Board of Trade rescue signal has attached to it 3 or 4 fathoms of marlin and a sinker. The bearing of some recognisable star having been taken, the signal is dropped overboard and the course of the ship altered so that the star and signal are both astern. The ship is run a mile, as measured by the log, and an observation is made of the elevation of the star over the signal. The altitude can then be corrected from tables. A table is given for correction for the dip of the signal due to waves of different heights, and another method of carrying out the observation by means of two stars is explained. G. E. A.

2004. *Repulsive Force of the Sun.* **H. Deslandres.** (Comptes Rendus, 134. pp. 1134–1136, May 20, 1902.)—The author points out that several of the suggestions propounded recently by Arrhenius, have been previously noted in various communications dealing with the results obtained from observations of the total eclipse of the sun at Senegal, West Africa, in 1893. The emission of kathode rays by the higher rarefied layers of the solar atmosphere has also been proposed by the present author and by Birkeland. The action of these on the earth's atmosphere is thus possibly concerned in the production of auroræ. C. P. B.

2005. *Computation of Spectroscopic Binary Orbit.* **H. N. Russell.** (Astrophys. Journ. 15. pp. 252–260, May, 1902.)—The author gives an extension of the method originated by Wilsing, in which the observed radial velocity of the system is developed into a trigonometrical series, and the elements are found by comparing this series with the corresponding analytical expression for the velocity. As developed by Wilsing, the method was only applicable to orbits of very small eccentricity.

The method at present in general use (that of Lehmann-Filhe, Astronomische Nachrichten, Band 136, 1894) is somewhat more expeditious in practice, but as in the new method described the orbit is determined from twelve points on the velocity curve instead of four, the result should be more accurate. C. P. B.

2006. *Kinetic Theory of Planetary Atmospheres.* **G. H. Bryan.** (Nature, 66. p. 54, May 15, 1902.)—This note is in criticism of an article by Rogovsky [see Abstract No. 446 (1902)], describing the possible escape of various gaseous molecules from the outer limits of the earth's atmosphere. Taking the statement that a gas would escape if the velocity required by a molecule to overcome the planet's attraction and fly off to infinity is not more than 10·22 times the most probable velocity, Bryan calculates that it is so rare for a molecule to attain such a speed that a period of $5{\cdot}371 \times 10^{10}$ years would elapse before a single cubic centimetre of gas (helium) could escape from the earth. From this he concludes that if helium is actually escaping some other factor must be in operation. C. P. B.

REFERENCES.

2007. *Some Peculiarities of Springs and a Spring Testing Machine.* A discussion by **S. W. Baldwin, A. A. Cary,** and **A. Kingsbury.** (Amer. Soc. Mech. Engin., Trans. 23. No. 924, pp. 277–297, 1902.)

2008. *Experiments on Helical Springs.* **C. H. Benjamin** and **R. A. French.** (Amer. Soc. Mech. Engin., Trans. 23. No. 925, pp. 298–302; Discussion, pp. 302–312, 1902.)

2009. *The Equilibrium of an Elastic Circular Cylinder.* **F. Hasenöhrl.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1026–1037, 1901.)—Jaerisch has integrated the differential equations of elastic equilibrium of a circular cylinder under prescribed surface conditions, starting from cylindrical co-ordinates. The author solves the problem for the infinitely long circular cylinder, with given surface-displacements or given surface-tractions, setting out from the Cartesian equations. W. S.

2010. *Archimedes' Principle in Gases.* **E. C. Sevérin.** (Annal. Sci. de l'Univ. de Jassy, 2. pp. 45–51, April, 1902.)—Experimental and demonstrational apparatus for the determination of the density of gases are described. A. D.

2011. *Artificial Horizon.* **F. Verde.** (Rivista Sci.-Industriale, 34. pp. 49–55, April 15, 1902.)—An application of photographic methods of observation to a gyroscopic apparatus. A. D.

2012. *The Constitution of Matter and Ether.* **J. Fraser.** (Roy. Soc. Edinburgh, Proc. 24. pp. 26–64, March, 1902.) G. W. de T.

2013. *Divisibility of the Atom.* **A. S. Mackenzie.** (Frank. Inst., Journ. 153. pp. 451–468, June, 1902.)—This is mainly a historical sketch of recent investigations. G. W. de T.

2014. *Fundamental Principles of Mechanics.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 876–896, April 19, 1902.)—This is an attempt to base mechanical science on one fundamental principle, as Hertz did in his "Prinzipien der Mechanik," without, however, assuming any hidden movements *within* masses invisible to us, as Hertz did. In order to be able to dispense with those ideas the author introduces the idea of force in the sense current in mechanics. A. G.

2015. *Bipolar Fields of Force of Diffusion.* **S. Leduc.** (Comptes Rendus, 134. pp. 1204–1205, May 26, 1902.)—Referring to his previous paper [see Abstract No. 1279 (1902)], the author gives a further account of his method of representation of fields of force by means of photographs showing the phenomena of diffusion, and proceeds to describe his representation of a bipolar field and his photographs of the spectra of these fields of force in liquids. J. J. S.

2016. *New Collimating-Telescope Gun-Sight for Large and Small Ordnance.* **H. Grubb.** (Roy. Dublin Soc., Trans. 7. pp. 321–329, 1901.)

2017. *New Geodetical Instruments.* **H. Grubb.** (Roy. Dublin Soc., Trans. 7. pp. 385–390, May, 1902.)—The principles of the author's gun-sighting apparatus are utilised in the construction of the plane table, level, prismatic compass, and clinometer. The instruments are suitable for rapid surveying where great accuracy is not required, such as road- and railway-making and property conveyancing. The probable error is less than two minutes of arc. Descriptions of the above instruments are given, with sections and several photographs of the instruments in use. G. E. A.

2018. *The Height Diagram.* **E. Hammer.** (Zeitschr. Instrumentenk. 22. pp. 81–88, March, 1902.)—The use of diagrams as an aid to the measurement of heights in surveying is discussed, and illustrated by diagrams and tables. G. E. A.

2019. *Geodesic Operations at the Equator.* **H. Poincaré.** (Comptes Rendus, 134. pp. 965–972, April 28, 1902.)—This is a summary of the Report made by **Bourgeois,** the chief of the expedition, to the Committee of the French Academy of Science. G. G.

2020. *Meteorological Observations made at the Perth Observatory and other Places in Western Australia, under the direction of W. E. Cooke.* (Meteorological Report, Perth Observatory, pp. 5–121, 1901.)

2021. *Circulation of the Atmosphere in High and Low Areas.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 117–125, March, 1902.)—General description of the vectors obtained by observation for elevations of 0, 1,000, 3,000, 5,000, 7,500, 10,000 m., and determination of the vector values. [See also Abstract No. 1997 (1902).] H. B.

2022. *Flood Forecasting for Rivers of Small Drainage Area.* **C. F. v. Herrmann.** (U.S. Weather Bureau, Bull. 31. pp. 158–167, 1902.)—The author discusses the difficulties of flood forecasting with special regard to North Carolina under the four headings of geological, topographical, and meteorological conditions, and of precipitations. H. B.

2023. *Fog Studies.* **A. G. McAdie.** (U.S. Weather Bureau, Bull. 31. pp. 31–34 ; Discussion, pp. 34–35, 1902.)—The paper concerns the fogs near San Francisco [see Abstracts No. 2389 (1900), and Nos. 602, 1250, and 1864 (1901).] Six beautiful photographs of fog clouds, comprising a remarkable fog pyramid, are reproduced.—The discussion by **Bigelow, Clayton, Odenbach,** and **Moore** deals with the production of ocean fogs by the intermixing of air currents. H. B.

2024. *Hurricanes, especially of Porto Rico and St. Kitts.* **W. H. Alexander.** (U.S. Weather Bureau, Bull. 32. pp. 7–79, 1902.)—The subject is discussed under the headings : Theories of the origin of rotary storms ; premonitory signs ; approach and passage of West Indian hurricanes ; barometers ; U.S. Weather Bureau in the West Indies ; historical notes on the hurricanes, earthquakes, &c., of Porto Rico and St. Kitts since 1515. [Compare Garriott, Abstract No. 604 (1901).] H. B.

2025. *Explanation of Celestial Phenomena by Hertzian Waves.* **C. Nordmann.** (Comptes Rendus, 134. pp. 530–533, March 3, 1902.)—The author summarises the reasoning suggested for explaining the various solar and cometary phenomena as the result of Hertzian waves originating in the solar surface. C. P. B.

2026. *Theory of a Cosmic Cycle.* **F. W. Very.** (Amer. Journ. Sci. 13. pp. 47–58, Jan. ; 97–114, Feb. ; and pp. 185–196, March, 1902.)—These three articles are already too condensed for detailed abstraction. The whole range of stellar evolution is discussed from the standpoint of modern thermodynamics and spectroscopy. C. P. B.

2027. *Spectra of the Aurora Borealis and of the Sun.* **H. Stassano.** (Annal. Chim. Phys. 26. pp. 40–57, May, 1902.)—The author has collected together measurements of as many lines as possible which have been observed by various physicists and compared them with Liveing and Dewar's measurements of the spectrum of the most volatile gases of the atmosphere. He has also done the same for the chromospheric and prominence spectra of the sun. He comes to the conclusion that the aurora consists of helium, hydrogen, neon, and argon. Many of Liveing's and Dewar's lines he selects are yet unassigned. E. C. C. B.

LIGHT.

2028. *Molecular Gratings and Dispersion* (I). **E. Carvallo.** (Soc. Franc Phys., Séances, 3. pp. 198–202, 1901.)—At the Congrès international des méthodes d'essais des materiaux de construction, in 1900, a paper was read by M. Ricour on the molecular constitution of bodies, in which reference is made to a theory of dispersion of colours advanced by Sénarmont in 1860. Sénarmont assumes the ether to have a periodic constitution, like a molecular grating, instead of being uniform. By means of an equation in finite differences, he derives a dispersion formula much like Baden-Powell's, containing only two constants. Ricour applied this formula with some success to Mascart's observations of quartz in the region 768 $\mu\mu$ — 336 $\mu\mu$. Carvallo, however, finds that on a more extended test, from 2171 $\mu\mu$ — 202 $\mu\mu$, it breaks down completely. He remarks further that it is impossible to explain the laws of double refraction by Sénarmont's method, or by any modification of it. A. E.

2029. *Alteration of Optical Properties of Glass by Elastic Deformation.* **F. Pockels.** (Ann. d. Physik, 7. 4. pp. 745–771, April 8, 1902.)—Experiments were carried out on several Jena glasses whose elastic and thermal properties were accurately known. The calculations were based on Neumann's equations for the influence of elastic deformation on the transmission of light in amorphous substances. The author arrives at the following conclusions: (1) Double refraction due to a state of thrust is, as has usually been assumed, negative for most glasses, but is positive for flint glasses containing a large percentage of lead. Hence it should be possible to make a flint glass containing lead in such proportion that there would be no double refraction for light of a certain wave-length. The result of an experimental melting tended to confirm this view. Dispersion due to mechanical thrust is generally so small as to be barely measurable. It is only considerable in the heaviest flint glasses. (2) Change of index, absolute or relative, due to hydrostatic compression increases with the density and index. The amount of change does not agree with any formulæ which have been put forward as connecting index with density. Newton's law $(n^2-1)/\rho =$ const., gives the best agreement, and Lorentz's the worst. (3) By the pure temperature coefficient of the index is meant the result obtained by subtracting the portion of the coefficient due to mere change of density. This quantity was calculated for four glasses, the value obtained being always positive, and increasing rapidly with the percentage of lead. (4) Dispersion may either increase or decrease as the pure temperature coefficient increases. A. E.

2030. *Chemical Action of Light.* **G. Ciamician** and **P. Silber.** (Accad. Lincei, Atti, 11. pp. 277–284, April 6, 1902.)—A solution of 60 grams of nitrobenzene in 200 c.c. of absolute alcohol was exposed to the action of light during the whole summer, after which 50 grams of unaltered nitrobenzene was recovered, the remaining compounds yielding 6·6 grams of a mixture of hydrochlorides from which were separated: quinaldine, aniline, a tertiary base and an aldehydic substance. *m*-Nitrotoluene gives the corresponding methyl-quinaldine and *m*-toluidine, the other nitrotoluenes yielding similar products. *o*-Nitropiperonaldehyde in benzene gives *o*-nitrosopiperonylic acid, whilst *o*-nitrocinnamaldehyde remains unchanged. *o*-Nitrobenzaldehyde in alcoholic solution yields mainly the two compounds, $NO_2 . C_6H_4 . CO_2C_2H_5$ and $ON_2(C_6H_4 . CO_2C_2H_5)_2$. T. H. P.

2031. *Testing Astronomical Objectives.* **H. Lehmann.** (Zeitschr. Instrumentenk. 22. pp. 103–109, April, 1902.)—In Hartmann's method [see Abstract No. 1018 (1900)], each zone of the objective is examined separately by covering the remaining surface and taking photographs within and without the focus, for micrometric measurement. The source must be monochromatic, and the following remarks therefore only apply to monochromatic observation. The author has used the method to test a great number of objectives, and finds that it enables the fundamental errors to be determined with a degree of accuracy far surpassing that attainable by any of the usual tests. The lens-polisher is therefore enabled to carry correction to a higher stage of refinement. The method is especially useful for the detection of small mechanical irregularities. Curves and tables are given illustrating the performance of lenses at different stages of correction. It is possible to make objectives giving very nearly point-images by monochromatic light, and in view of the high resolving power thus obtainable, the author suggests that double-stars and fine planetary details might be observed monochromatically by employing various light filters. The objective need then only be corrected for spherical aberration. A. E.

2032. *Lenses for Keratocone.* **J. Janssen.** (Comptes Rendus, 134. pp. 1121–1123, May 20, 1902.)—In this affection the front of the cornea assumes a projecting parabolic form which induces an extreme myopia. To compensate this lenses may be used whose inner surface corresponds to the abnormal and the external to the normal form of the cornea: but in practice a spherical form given to the inner surface works better for objects off the optic axis. If necessary, another ordinary lens may be added for any ordinary shortsightedness which may be present. A. D.

2033. *Photo-Micrographic Device.* **F. E. Ives.** (Frank. Inst., Journ. 153. pp. 371–378, May, 1902.)—Assuming that the eye can focus parallel rays, either unaided or with the aid of a supplementary lens, the object is brought into focus in the microscope in the ordinary way. Then on a baseboard there is a support for a camera attachment, into which the microscope is put in position after having been adjusted; this camera attachment has the same rotation as the body of the microscope, and can therefore be brought to fit the microscope without altering the slope of the latter. The camera has a 10-in. lens and 10-in. box: this brings the parallel rays from the microscope to focus on the plate with the same amplification as the eye saw in the microscope. Monochromatic light is best, and isochromatic plates. This arrangement can be relied upon to reproduce clearly whatever detail the eye saw in the microscope. A. D.

2034. *Stopping down Lens of Human Eye.* **W. Andrews.** (Nature, 66. p. 31, May 8, 1902.)—The author, who uses convex spectacles, can read the smallest print at 4 in. through an aperture one-fiftieth of an inch in diameter in a metallic disc. This corresponds to stopping down the lens to about *f*/25. A. D.

2035. *Urine as a Photographic Developer.* **R. A. Reiss.** (Comptes Rendus, 134. pp. 1207–1208, May 26, 1902.)—The latent image of an exposed plate is not developed when treated with fresh urine, but if the latter be rendered alkaline by the addition of a solution of potassium carbonate, that image appears rapidly without, however, sufficient density being obtained to enable a satisfactory point to be made. The prolonged action of the urine developer fails to secure an increased density. The negative can, however, be intensified by the ordinary mercury or uranium methods, and fixation can be effected by the use of the hyposulphite of soda bath. The colour of the reduced silver is yellowish. On the addition of potassium carbonate to the urine, ammonia is liberated as a result of the partial decomposition of the urea contained in the urine which takes place. Urine which has become alkaline by exposure to the air developes the latent image without the addition of potassium carbonate.

Ordinary developers such as hydroquinone, pyrogallol, &c., when diluted with urine instead of water were found to be much more energetic in their action, without the tendency to fog being sensibly increased. The active agent in urine was found to be urea, a solution of the chemically pure substance and potassium carbonate developing the latent image. C. E. A.

2036. *Quartz Prisms.* **R. Straubel.** (Ann. d. Physik, 7. 4. pp. 905–908, April 8, 1902.)—Cornu and v. Lang have shown how the peculiar doubly refracting property of quartz in the direction of the optic axis may be made manifest by means of a single prism, having the plane bisecting its vertical angle perpendicular to the optic axis, and which is set for minimum deviation. Suppose now that instead of the whole prism we take one of the half-prisms, obtained by cutting through the plane of bisection, and, adopting an auto-collimation arrangement, allow the light to be internally reflected at the cut surface. At first sight this arrangement would appear to be equivalent to the foregoing. The author, however, found no trace of doubling of spectrum lines. The following is the explanation : A wave refracted into the prism in the direction of the optic axis is separated into two which are circularly polarised in opposite senses, and have different velocities and therefore different indices of refraction. The deviation again depends on the index. Hence, with Cornu's prism, a single incident-wave gives rise to two emergent-waves deviated in different direction. But reflection changes a right-handed rotation into a left-handed, and *vice versâ*. Hence in the half-prism, the component which is least deviated on entering and travels fastest before reflection, will travel slowest after reflection and be most deviated at emergence. The total deviation is therefore the same for both waves. The fact that the auto-collimation method gives single lines with a quartz prism with its second face cut perpendicular to the axis, may have some importance for spectrographic investigations in the ultra-violet. The method possesses one advantage over Fraunhofer's in requiring only one objective of fluorspar instead of two. If the unreflected light emerging from the second face of the prism is observed through a telescope the lines still appear double ; and the increased separation towards the blue end of the spectrum, owing to the dependence of rotation upon wave-length, is very marked. By revolving the prism the observer can convince himself that the two images never quite coincide, showing that the two sections of the wave-surface by a cross-section of the prism have no common point. The same phenomena are seen on reversing the arrangement so that the light is incident normally at the face perpendicular to the axis. A telescope of power 6–8 was sufficient to show the effect, and with a power of 15 diameters all the lines were doubled. The half-prism had an angle of 30°. A. E.

2037. *Mascart's Ether Experiment.* **R. Wachsmuth** and **O. Schönrock.** (Deutsch. Phys. Gesell., Verh. 4. 8. pp. 183–188, April 25, 1902.)—As a contribution towards a repetition of the above experiment to find whether the earth's motion affects the rotation of the plane of polarisation of an E-W ray passing through quartz, the authors criticise Mascart's arrangement and especially his use of very thick quartz plates. By the use of quartz plates of thicknesses 109·6, 24·1, and 7·4 mm. it is shown that the percentage error in measuring the angle of rotation is pratically constant. Hence they conclude that pure quartz plates about 1–3 cm. thick are better than very thick plates, and that if the difference to be observed should be more than 1/100000 of the angle of rotation, this could be demonstrated by means of a half-shadow polarimetre. G. E. A.

2038. *Differential Equations of Fresnel's Polarisation Vector.* **J. Walker.** (Roy. Soc., Proc. 70. pp. 37–43, May 12, 1902.)—In this paper, the equations for crystalline media are derived in a manner analogous to that used by Voigt in the case of isotropic media, in place of deducing them, as done by Voigt, from the isotropic equations by means of the principle of least action. Extensions are suggested of Fresnel's theorem respecting the ellipsoid of polarisation to active crystals, including those magnetically active.
G. W. de T.

2039. *Magnetic Rotation-Polarisation of Absorbing Substances.* **H. du Bois.** (Ann. d. Physik, 7. 4. pp. 944–945, April 8, 1902.)—In view of several papers recently published on this subject, the author calls attention to some remarks made by himself (Rapp. Congr. de Phys. 2. Paris, 1900) to the effect that the magnetic rotary polarisation for the compounds of the different metals of this series is of varying sign. He further states that he has not been able to observe any particular effect exerted by magnetism on the very characteristic absorption spectrum of a solution of strongly magnetic erbium chloride. T. H. P.

2040. *The Zeeman Phenomenon.* **A. Korn** and **K. Stoeckl.** (Ann. d. Physik, 8. 2. pp. 312–325, May, 1902.)—This is the first of a series of papers dealing with magneto-optics, dispersion, and aberration. The authors proceed from that form of the electromagnetic theory of light in which the light vector is taken proportional to the electric intensity vector, and they will show that the phenomena in question can be explained by the mechanical conceptions of electric phenomena which are the basis of the hydrodynamical theory. The ether is a fluid incompressible when rapid motions are concerned; a conductor is a continuous mass-system endowed with friction; a dielectric consists of the ether and embedded conducting particles, which, however, are in general so far apart that frictional forces do not come into play. To explain the Zeeman effect the authors employ the Faraday-Maxwell idea that a magnetic particle possesses a rotation, the moment being proportional to the angular velocity; on the hydrodynamical theory (see Korn, Sitzungsber. d. math.-phys. Kl. d. bayer. Akad. d. Wissensch. 28. p. 129, 1898) a particle rotating with very great velocity is a magnet whose axis is that of rotation and moment proportional to the angular velocity. The ordinary Zeeman doubet is explained either on the Faraday-Maxwell rotation hypothesis or on the hydrodynamical theory of magnetic particles; the triplet cannot be explained on the basis of purely transversal waves, but necessitates consideration of the longitudinal component; the Cornu quadruplet and the inverse triplet of Becquerel and Deslandres, which have not hitherto been deduced (without assuming complex ions) from the electromagnetic theory of light, are explained on the basis of the hydrodynamical theory. W. S.

2041. *The Optical Rotation of Sugar Dissolved in Amines.* **G. M. Wilcox.** (Journ. Phys. Chem. 6. pp. 339–342, May, 1902.)—The author has already shown that sugar has a higher rotation in pyridine than in water [see Abstract No. 30 (1902)]. He now finds that allylamine, amylamine, isopropylamine, and ammonia act in the same way as pyridine. On the other hand, the hydroxides and salts of the alkali metals when added to aqueous sugar solutions cause the rotatory power to decrease. D. H. J.

2042. *The Constitution of Matter and Spectroscopy.* **B. Eginitis.** (Comptes Rendus, 134. pp. 1137–1139, May 20, 1902.)—From his own experiments and those of Schuster and Hemsalech [see Abstract No. 1066 (1900)] on the spark spectrum, the author draws the following conclusions: The intensity of the different rays of a metal depends on the nature of the metals present along with it and on the nature of the medium. Some rays of the simple metals form groups whose variations are due probably to difference in constitution of the radiating particles and in the nature of the poles. A relation seems to exist between those groups and the groups of rays which issue from the poles with equal velocities. During the discharge metallic vapours exhibit properties varying with their nature, and differing considerably from those of air. The constitution of matter may be examined by using varying inductance in the circuit. W. S.

2043. *Polar Light Observations at Göttingen.* **E. Wiechert.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 182–184, 1902.)—Observations conducted at the new geophysical observatory near Göttingen with a powerful spectroscope, made by Brunnée, since November, 1901, demonstrate that the polar light line is very frequently—but not always—discernible in the north and east, further at some elevations in the south and occasionally all over the sky. To the naked eye nothing beyond a faint luminiscence was ever visible. H. B.

2044. *Actino-electric Phenomena.* **A. Nodon.** (Comptes Rendus, 134. pp. 1491–1493, June 23, 1902.)—When luminous, or ultra-violet, radiations fall upon one face of a thin conducting plate, the other face emits radiations similar to Röntgen or radium rays. This is shown by suspending a brass sphere within a blackened zinc case, and projecting upon the latter a pencil of rays from the voltaic arc, or magnesium, or the sun. The sphere is insulated and forms with the zinc case a condenser which is connected to a single gold-leaf electrometer. The sphere being charged, the incidence of the light produces discharge as shown by the electrometer, although the sphere is completely shielded from any direct incidence of the light. The discharge is rapid in proportion to the intensity of the light and to the presence of radiations of small wave-lengths. These radiations, induced on the dark side of a thin metal plate or the bright side of a thick metal plate, can traverse easily thin sheets of metal, and also wood, glass, &c. They differ from kathode rays, and appear to possess properties intermediate between those of Röntgen and radium rays. The author terms them radio-actinic rays. J. W. P.

2045. *Röntgen Rays.* **J. Wimshurst.** (Röntgen Ray, Archives, 6. pp. 102–104, May, 1902.)—Röntgen rays originate upon the anode immediately over the end of the positive terminal wire, and the point of light from which these rays originate is hemispherical in form; from this the rays move outwards radially in every direction, a slightly greater efficiency being imparted to those rays which move outwards in lines which are at a small angle to the plane of the anode. The tube when excited emits invisible (Röntgen) rays of great penetration, and also visible light which is slightly penetrative either when used direct or when reflected. Both the Röntgen rays and the visible light enter into and fill the whole space of the apartment in which the tube is excited. When the Röntgen rays are passing out from the tube they will even without any reflector enter and pass through a tube which is placed at a right angle or at any angle to their normal course; the loss of efficiency is, however, considerable. The dense metals are more efficient than the lighter metals when used as reflectors. Possibly the great resistance may generate heat and, following this, light, and also Röntgen rays of rapid vibration immediately in front of the anode. A. D.

2046. *Phosphorescence in Röntgen-ray Bulb.* **J. H. Gardiner.** (Röntgen Ray, Archives, 6. pp. 104–106, May, 1902.)—The probability is very strong that the phosphorescence in an excited Röntgen-ray bulb, which is bounded by the anti-kathode zone, is due, not to the reflected kathode stream, but to easily absorbed Röntgen radiations, which give up their energy partly as phosphorescence, and also produce secondary Röntgen radiations at the illuminated surface. A. D.

2047. *Chemical Reactions Produced by Radium.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 452–458, April, 1902.)—The author, after an account of researches already described [see Abstracts Nos. 298 and 459 (1902)], suggests that the observations should lead to a series of methodical experiments designed to compare together the actions of light, those of the electric effluvium, and those of radium, in determining chemical transformations, and as serving as sources for the energy consumed in these transformations.

J. J. S.

2048. *Induced Radio-activity.* **A. Sella.** (Accad. Lincei, Atti, 11. pp. 369–378, May 4, 1902.)—In the Rendiconti of the Accad. Lincei, xi. p. 242 (Abstract No. 1520 (1902)], the author showed that on long leaving within a closed space the air exposed to emanations from thoria and producing an electric effluvium in this air between a point and a plane, that portion of the plane which was struck by the effluvium became radio-active with contours corresponding to those of Kundt's electric figures. Kundt's figures can be readily obtained by producing an effluvium in air rendered smoky by a smoky flame or by the dust from burning magnesium, the dust being at once deposited on the metal. With stale thoriated air the induced radio-activity is the same whether the points are positive or negative; and it is as if the thoria emanations had in time agglomerated into something resembling lampblack or magnesia dust. When this thoria dust has once settled down, a second effluvium between another point and plane in the same space will not produce any effect; the first effluvium has cleared the enclosed air of thoria dust. On filtering the stale thoriated air through wadding the dust is removed, but the wadding becomes powerfully radio-active; fresh thoriated air is not affected in this way. Stale ordinary air presents similar phenomena in minor degree, but the radio-activity of the wadding used as an air-filter very rapidly falls off. On electrolysing the commercial liquid for impregnating incandescent mantles (a solution of 99 per cent. nitrate thoria, 1 per cent. of nitrate ceria) the negative electrode becomes powerfully radio-active, the radio-activity rapidly falling off afterwards; nitrate of uranium gives no result. A. D.

REFERENCES.

2049. *Total Reflectometer.* **C. Klein.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 8. pp. 104–119, Feb. 13, 1902.)—This is a continuation of an 1889 paper. In Part 3 total reflectometers suitable for investigating thin plates of crystal are discussed, and Part 4 treats of the system of crystallisation of pennin and of an unsuccessful attempt to explain its structure by means of crossed, biaxial lamellæ. G. E. A.

2050. *Stokes' Theory of Aberration in Ether of Variable Density.* **H. A. Lorentz.** (Archives Néerlandaises, 7. pp. 81–87, 1902.)—This is a French translation of the author's paper in Akad. Wetensch. Amsterdam Verslagen, 7. p. 523, 1899. G. W. DE T.

2051. *Application of Diffraction to Astronomical Measurements.* **C. Hillebrand.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 989–1025, 1901.)—The only reliable method for measuring the apparent diameter of a source of light such as a fixed star is that in which diffraction phenomena are produced by two slits or mirrors placed in front of the objective of the telescope. It was first used with success by Michelson (see Phil. Mag., 1890). The author gives a complete analysis and critical discussion of the method for slits and mirrors when the source is circular or elliptic, or when there are two circular sources. W. S.

2052. *Photographic Permanence.* **C. F. Himes.** (Frank. Inst., Journ. 153. pp. 359–370, May, 1902.)—The principal point made in this lecture is that a first-class albumen print may be regarded as the standard of permanence, not on *à priori* grounds, but as an experimental fact. C. E. A.

2053. *Photography of Disturbances in Air.* **H. S. Allen.** (Nature, 65. pp. 575–576, April 17, 1902. From Proc. Roy. Philosoph. Soc. Glasgow, Dec. 4, 1901.)—Methods are described, based on Toepler's method of striæ. Electric discharges produce initial variations of density comparable to explosions rather than to sound-waves; but the subsequent oscillations produce very little compression. Experiments on flames, jets, and vortex-rings are described. A. D.

2054. *Photographic Appliances.* **O. Hertwig.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 22. pp. 450–454, April 24, 1902.)—Apparatus described, made by Zeiss, with mirror and inversion prism, for photographing such objects as frog's eggs in course of development, from above and from below, in rapid succession. A. D.

2055. *Photographic Papers.* **A. I. Cohn.** (Soc. Chem. Ind., Journ. 21. pp. 582–587, May 15, 1902.)—The paper deals very fully with the manufacture and practical employment of blue-print and black-print photographic papers. G. W. DE T.

2056. *Radio-activity and the Constitution of Matter.* **R. P. Lucas.** (Soc. Belge Élect., Bull. 19. pp. 289–305; Discussion, pp. 305–309, May, 1902.)—The paper gives an excellent sketch of the present state of knowledge of radio-activity. G. W. DE T.

2057. *Actinism of Röntgen Rays.* **J. O. Heinze, Jr.** (Amer. Journ. Sci. 13. pp. 313–314, April, 1902.)—Experiments to show that photographic effect may fall off where fluorescent effect increases. A. D.

HEAT.

2058. *Thermal Expansion of Porcelain.* **A. E. Tutton.** (Phil. Mag. 3. pp. 631–642, June, 1902. Paper read before the Physical Society, March 14, 1902.)—Bayeux and Berlin porcelains are employed for the reservoirs of air thermometers. Hence an exact knowledge of the expansion is practically valuable. The Bayeux variety is here investigated by the interference dilatometer. Advantages here attained over the Fizeau method are: (1) The employment of a micrometer method of measuring the position and width of the interference bands; (2) use of auto-collimation; (3) use of C hydrogen light in place of sodium light; (4) special arrangement which permits extension of the range up to 120°. An aluminium compensator is used for reflecting the hydrogen light, as the porcelain is incapable of polish. The specimens used were tubes about 12 mm. long, 17 mm. diameter, and 3 mm. wall thickness. Tables of readings are given for three specimens; the mean value of the linear coefficient $(a + bt)$ between 0° and 120° is $10^{-9}(2522 + 7{\cdot}43t)$. Comparison with the results of Bedford and Chappuis, and criticism by Callendar, is given. J. W. P.

2059. *Variable and Absolute Specific Heats of Water.* **J. Macfarlane Gray.** (Inst. Civil Engin., Proc. 147. pp. 3–32, 1901–1902.)—Assuming that water would have a constant specific heat if bereft of volume, the author, by a process which is not clear and can only be approximate, finds—as previously in 1889—an expression of the form $\theta d(vdp/d\theta)/d\theta$ for its extra specific heat when it occupies volume v at the absolute temperature θ. The circumstances of the differentiations are not specified nor clearly determined, but in the calculations made the values of $dp/d\theta$ are taken for the saturated states. So interpreted, this formula appears to agree very satisfactorily with the results of Callendar and Barnes's experiments, which range from 4° to 60° C., and also with the results deducible from Regnault's experiments at higher temperatures when proper allowance is made for the variation of the specific heat of the cold water in his calorimeter. [See also Abstract No. 1879 (1899).] R. E. B.

2060. *Specific Heats and Heats of Evaporation of the Paraffin and Methylene Hydrocarbons.* **C. F. Mabery** and **A. H. Goldstein.** (Amer. Acad., Proc. 37. pp. 539–549, March, 1902.)—With the paraffin hydrocarbons the author finds there is a uniform decrease in the specific heat as the molecular weight increases. It is found also that the product of specific heat and molecular weight divided by the number of atoms in the molecule gives an almost constant number, 2·23, for all the members of this series examined. For the methylene hydrocarbons, C_nH_{2n}, a similar relation holds, the constant having a slightly higher mean value. Various crude oils from different sources were also examined, and the author concludes that the specific heat must be regarded as an important property from a practical point of view. Results are also given of several measurements of the heat of vaporisation. The numbers obtained indicate a rapid falling off in latent heat as the molecular weight increases. T. H. P.

2061. *Vapour Composition.* **H. R. Carveth.** (Journ. Phys. Chem. 6. pp. 237–256, April, and pp. 321–338, May, 1902.)—Using an apparatus of the type of the Landsberger Boiling-Point Apparatus it is shown how the boiling-points of saturated solutions may be determined by bubbling vapour of the solvent derived from the saturated solution into the saturated solution *plus* solid non-volatile solute contained in the inner tube. Reference is made to the lowering effect produced by the presence of excess of solid solute on the apparent boiling-point of a saturated solution. In this method of vapour-heating superheated vapour derived from a higher boiling solution may be employed. This procedure is stated to be the only one which gives accurate results. The boiling-point curve for a mixture of two volatile components may be similarly studied. In the case of three components the displacement in vapour composition produced by the addition of the third component is discussed. It is pointed out that the work of fractionation will be hindered if the third component added is more soluble in the more volatile component, and helped if it is more soluble in the less volatile component. Other more complicated cases are considered. F. G. D.

2062. *Molecular Attraction.* **J. E. Mills.** (Journ. Phys. Chem. 6. pp. 209–236, April, 1902.)—From the application of the gas law to solutions the author concludes that the total energy *per se* of a molecule must be the same in the liquid as in the gaseous state at the same temperature, and that therefore, in general, the energy to change a liquid into gas is spent in overcoming the external pressure and in altering the distance apart of the molecules. Assuming that the attraction between the molecules varies inversely as the square of their distance apart, he deduces the formula $(L_T - E_{1T})/(L_t - E_{1t}) = (\sqrt[3]{d_T} - \sqrt[3]{D_T})/(\sqrt[3]{d_t} - \sqrt[3]{D_t})$, where L_T, E_{1T}, d_T, D_T are, for temperature T, the latent heat, energy required to overcome external pressure, and densities corresponding to volumes v and V. This affords a means of testing the above assumption, and the results are in its favour, and also show that the absolute molecular attraction is only slightly affected by changes in temperature, and depends primarily upon the chemical constitution of the molecule and not upon its mass. Confirmation of these conclusions is obtained by means of Crompton's equation, $L_T = 2RT \log_e (d/D)$, which he deduced from different theoretical considerations. W. E. T.

2063. *Translation-energy of Liquid Molecules.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1141–1145, 1901.)—This paper purports to give a simple proof of the proposition that the average translation-energy of the molecules of a substance in a saturated state is the same whether the phase is liquid or gaseous. It consists in showing [by the help of assumptions and approximations] that the saturation-pressure of a vapour depends especially, according to one calculation, on a factor $exp(-rJ/RT)$, where r is the latent heat of vaporisation and the other letters have their usual signification, and, according to another, on a factor $exp(-3a/mc^2)$, where a denotes the work required to transfer a molecule of mass m and speed c from the interior of a liquid to the interior of its vapour, and in identifying these two factors. Now $rJ = na$, if n is the number of liquid molecules in unit mass, and $RT = \frac{1}{3}nmc^2$ on the kinetic theory of gases, if n, m, c refer to *gaseous* molecules; hence $\frac{1}{2}nmc^2$ (and so c^2) is the same for molecules in both the liquid and the gaseous phase. The author then tacitly assumes that n is the same in both phases. R. E. B.

2064. *Application of the Phase-rule to the Melting-points of Copper, Silver, and Gold.* **T. W. Richards.** (Amer. Journ. Sci. 13. pp. 377–378, May, 1902.)—This is a theoretical note on the results obtained by Holborn and Day. The constant melting-point of 1,064° found for gold [see Abstract No. 810 (1901)] is due to the fact that gold does not dissolve or combine with the oxygen or nitrogen of the atmosphere. Silver, however, dissolves oxygen, and as there are accordingly two components and only three phases there is one degree of freedom. If a constant oxygen pressure were maintained a new condition would be imposed, and two components in three phases would suffice to produce an invariant system. But the great variation of the solubility of oxygen in silver with the temperature renders such a theoretically invariant system practically variable. The case of copper is very interesting. If copper be melted in air with full opportunity for oxidation, the temperature observed, 1,065°, is far more constant and trustworthy than the higher temperature of 1,084° which is obtained when air is rigidly excluded. In the former case there are two components, copper and oxygen, and *four* phases, namely, solid copper, solution of cuprous oxide in melted copper, liquid cuprous oxide, and vapour; hence an invariant system. The latter case corresponds to the simple invariant system, solid copper, liquid copper, and vapour. F. G. D.

2065. *Fundamental Equations of the Multiple-Point.* **P. Saurel.** (Journ. Phys. Chem. 6. pp. 261–264, April, 1902.)—Determinantal equations are given connecting the slopes of the $n + 2$ pressure-temperature curves which converge to an $n + 2$ multiple point, with the specific volumes, specific entropies and concentrations of the components which have been given by Riecke (Göttingen Nachrichten, p. 223, 1890; Zeit. Phys. Chem. 6. 268, 1890). Other forms of these generalised equations are considered in the present article. [See also Abstract No. 1354 (1901).] F. G. D.

2066. *Maximum External Work in Isothermal Evaporation.* **S. Meyer.** (Ann. d. Physik, 7. 4. pp. 937–941, April 8, 1902.)—Dieterici has pointed out [see Abstract No. 696 (1902)] that for every substance there must exist a temperature and pressure for which the external work performed along the two-phase liquid-vapour saturation curve in isothermal evaporation is a maximum, since for the (reduced) pressures $\pi = 0$ and $\pi = 1$ the above work is zero. From a comparison of existing experimental data Dieterici found the temperature corresponding to this maximum condition to be the same for all substances, namely, $\tau = 0{\cdot}77$, where τ = reduced temperature. It is pointed out by Meyer that this result is a necessary consequence of the lack of specific constants in van der Waals reduced equation, and he shows how to calculate the temperature and pressure corresponding to the maximum work curve by a tentative graphical method, making use of Maxwell's condition. In this way he shows that $\tau = 0{\cdot}700$. F. G. D.

REFERENCE.

2067. *Energy and Entropy of Mixtures.* **P. Koturnitzky.** (Jurn. Russk. Fisik. Chimičesk, Obščestva, 34. 2b. pp. 29–33, 1902.)—The exact expressions for the energy and entropy of a mixture of bodies in two states, as developed in this paper, have certain integral terms instead of g and t respectively in the ordinary expressions, A. G

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

2068. *Field of Force of an Electric Charge in Uniform Motion.* **H. Bucherer.** (Ann. d. Physik, 8. 2. pp. 326–335, May, 1902.)—The author assumes the ether to be at rest, and regards all currents as displacement currents, a current being conditioned by motion of lines of displacement with reference to a system of axes fixed in the ether. The displacement is the sum of two parts, the first belonging to the ether alone and equal to the electric intensity, the second due to the presence of the dielectric. The author makes use of a vector F derivable from a scalar potential; it has been employed by Lorentz and by Searle, who have shown it to denote the mechanical force exerted by the moving charge on a unit charge taking part in the motion, while J. J. Thomson has proved that the components of electric and magnetic intensities can be expressed in terms of it. If the motion take place in the direction of x with velocity u ($< v$) and we write $\mu K v^2 = 1$ and $1 - (u^2/v^2) = s$ and refer everything to a co-ordinate system taking part in the motion, Thomson's results are $E_x = F_x$, $E_y = F_y/s$, $E_z = F_z/s$ for the electric intensity components, and $H_x = O$, $H_y = - KuF_z/s$, $H_z = KuF_y/s$ for the magnetic. The author shows that if the charged ellipsoid (a, b, b) move with uniform velocity $u < v$ parallel to a in a medium of dielectric constant K, then the potential over the surface is equal to that over an ellipsoid a, $b\sqrt{s}$, $b\sqrt{s}$ at rest in a medium with constant $K/s = K'$, and that the expression for the whole energy of the moving ellipsoid remains correct when K, F_x, F_y, F_z are replaced by K', F'_x, F'_y, F'_z. A very important property of the function F is its symmetrical distribution with reference to a plane through the equatorial section of the ellipsoid; it follows that the electric intensity, the distribution of energy, and the vector product EH are also symmetrical with reference to that section. W. S.

2069. *Electrification and Rate of Evaporation.* **A. Pochettino.** (Accad. Lincei, Atti, 11. pp. 376–380, May 4, 1902.)—A *résumé* is given of previous experiments. The author, measuring the rate of diminution in size in dry air of a drop perched on an electrified wire, finds that electrification retards evaporation feebly but sensibly. The surface-tension effect is not sufficient to account for the amount of retardation observed. No difference was found between positive and negative electrifications. A. D.

2070. *Dispersion of Atmospheric Electricity in Austria.* **F. Exner.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 231–237, 1902.)—Experiments conducted in the four stations of the Vienna Academy, at Vienna, Trieste, Kremsmünster, and Innsbruck, in the first three by means of mechanically registering apparatus with the aid of radium-collectors, which agree well with a water collector (at Vienna). The observers are Conrad, E. Mazelle, P. F. Schwab, and P. Czermak. The negative dispersion predominates at the first three stations, the positive at Innsbruck. The most complete work as to clouds, wind, and other features is done at Trieste, H. B.

2071. *Dispersion of Atmospheric Electricity at Munich.* **H. Ebert.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 219–230, 1902. From the Physik. Institut der Techn. Hochschule at Munich.)—Experiments made by the author, C. W. Lutz, and C. Ruf in the open at Munich and on the Starnberg Lake, in a cellar, and in the laboratory, with apparatus of the author's and of Elster and Geitel. Earthing the roof of the apparatus affects the results. Abnormally high dispersions for negative electricity were observed on the swampy lake-shore, very low values in dense forests; before thunderstorms the values are very high. The cellar of 500 c.m. has no windows, and is only lighted by electric glow-lamps. The dispersion figures are very high; negatively charged and even electrically neutral wires became radio-active in the stagnant air, and insulated conductors assume negative charges. The laboratory tests concern dispersion in glass vessels filled with various gases and liquid air. H. B.

2072. *Dispersion of Atmospheric Electricity at Capri.* **J. Elster.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 193–218, 1902.)—Essentially tables of the results of the observations which V. Cuomo has been making since October, 1901, in a garden, situated on a cliff close to the sea on the island of Capri, generally at 1 p.m. in the shade, with apparatus of Elster and Geitel. The dispersion rate is high and about equally rapid for negative and positive charges. H. B.

2073. *Lightning Recorders and Thunderstorm Forecasts.* **J. Kenealy.** (U.S. Weather Bureau, Bull. 31. pp. 76–78, 1902.)—The author describes and illustrates the apparatus set up by Odenbach at the Jesuit College of Cleveland, Ohio, whose copper-covered steeple rises to a height of 150 ft. The apparatus consists of coherer with brass electrodes and powdered nickel and silver in a glass tube, and a sounder as decoherer, which also carries the recording style. Lightning has often been recorded by a short line nine hours before any thunder was heard. H. B.

DISCHARGE AND OSCILLATIONS.

2074. *Water-Vapour in Gaseous Electric Conduction.* **P. Lewis.** (Phil. Mag. 3. pp. 512–514, May, 1902.)—Trowbridge having expressed his conviction that pure gases, hydrogen especially, are perfect insulators, and that therefore water-vapour or oxygen are necessary to produce the dissociation upon which conduction depends, the author opposes that view partly on general grounds and partly from the evidence of his experiments with sodium in vacuum-tubes. He considers that in the cases tried by him no water-vapour or oxygen could be present. P. E. S.

2075. *Temperature of the Electric Arc.* **C. Féry.** (Comptes Rendus, 134. pp. 1201–1204, May 26, 1902.)—Since the temperature of the crater of the arc is independent of the current, it represents, according to Violle, the temperature of ebullition of the carbon. Its determination is therefore a matter of importance. By extrapolation of results obtained from various physical properties, values ranging from 3,500° to 4,100° have been obtained. The author, by application of Stefan's law, has obtained a result near the lower of these limits. To control this result measurements have been made with an improved form of optical pyrometer, Chatelier's pattern. Assuming Wien's formula $I_0 = C\lambda^{-5}e^{-\frac{C\lambda}{\theta}}$ as representing the radiation from a perfectly black body, the pyrometer is compared with a platinum-platinum rhodium couple between 1,100° and 1,500°. From these observations it appears that Wien's law is true within these limits. By extrapolation, the temperature of the arc is deduced from observations on it with the pyrometer, using a red and a green ray. These give the temperature as 3,867° and 3,897° respectively. As this was higher than the value deduced above, it was thought that impurities in the carbon affected the result. A repetition of the observations with graphitic carbon gave concordant values. The conclusion is therefore drawn that, at the temperature of ebullition, carbon does not behave as a perfectly black body. [See also Abstract No. 1700 (1902).] R. S. W.

2076. *Measurement of ϵ/μ in Kathode Rays.* **W. Seitz.** (Ann. d. Physik, 8. 2. pp. 233–243, May, 1902.)—The various methods which have been used to determine the value of $\mu v^2/2\epsilon$ in kathode rays are: The potential of discharge method of Kaufman and Simon; the electrostatic deflection method of Wien and Lenard; and the bolometric method of J. J. Thomson. The author in this research determines the value of $\mu v^2/2\epsilon$ by all three methods in one and the same tube, and compares the accuracy to be obtained by the three methods. The experimental results at potentials above 8,500 volts are given in tables in the paper. All three methods lead to the same result, but the bolometer method fails at lower potentials. The electrostatic deflection method is considered the simplest and most accurate. To determine ϵ/μ and v the magnetic deflection was also measured, and the results are given in the following table :—

V.	$\frac{\epsilon}{\mu} \times 10^{-7}$.	$v \times 10^{-10}$.
8490	1·90	0·572
9410	1·92	0·604
9740	1·89	0·603
10420	1·86	0·627
11040	1·85	0·640
11120	1·825	0·639
11580	1·885	0·661
12900	1·90	0·700
14700	1·82	0·730
15110	1·85	0·748
	1·87	

The mean 1·87 compares well with Simon's value, 1·865. J. B. H.

2077. *Reflexion and Secondary Emission of Kathode Rays.* **L. Austin** and **H. Starke.** (Deutsch. Phys. Gesell., Verh. 4. 6. pp. 106–126, March 21, 1902.)—A reflecting metal surface is placed in the path of the kathode rays produced by an influence machine, and is connected to earth through a galvanometer. When the rays strike the reflector perpendicularly, the galvanometer shows a negative stream, but if it is turned round an axis in its own plane, so as to increase the angle of incidence gradually, the earth current decreases, becomes null, and may finally attain a positive value greater in actual magnitude than the initial negative current. The conclusion is drawn that the reflector itself becomes a source of negative electricity, this taking the form of a cloud of negatively charged particles, of the same order of magnitude and velocity as those forming the kathode rays. The experiments described in the paper show that this emission decreases with the velocity of the incident kathode rays, but is independent of the gas pressure. The greater the polish or the density of the reflecting metal, the stronger are the secondary rays; they are also increased by an increase in the angle of incidence. The density of the reflector and the percentage reflexion at normal incidence are nearly proportional, and at this incidence the reflecting power for the same metal appears to be independent of gas pressure and of the potential between the electrodes—at least within the limits 3,000–30,000 volts. R. S. W.

2078. *Reflexion of Kathode Rays.* **J. Stark.** (Deutsch. Phys. Gesell., Verh. 4. 8. pp. 167–182, April 25, 1902.)—The paper is chiefly a reply to criticisms by Austin and Starke [see preceding Abstract] on an earlier paper of the author's [see Abstract No. 1123 (1902). He arrives at the following conclusions: (*a*) The joint experiments of Austin and Starke contain nothing which is in contradiction to the theory he has advanced; (*b*) that in experiments on the reflexion of kathode rays, errors are usually made in neglecting the Volta currents between kathode and reflecting surface, the diffusion of the ions, and the secondary emission of the rays. R. S. W.

2079. *Electric Discharge in Flames.* **J. Semenov.** (Comptes Rendus, 134. pp. 1199–1201, May 26, 1902.)—A description of various experiments in which a spark from an induction coil is allowed to pass from one flame to another. As in Geissler tubes, a great dissymmetry with respect to the poles is noticed. The discharge starts from the anode, runs up the outer sheath of the flame, leaves it in a direction normal to it at that point, and stops about a centimetre from the negative flame. The obscure part of the first flame is thus rendered luminous up to the point where the discharge leaves it: above this point the outer sheath disappears entirely, giving rise to a thick deposit of carbon. As in tubes, the heating effect at the negative pole is considerably greater than at the positive. There appears to be a transport of material particles in the direction of the current. R. S. W.

2080. *Kathode Rays of Small Discharge Potential.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 4. 9. pp. 204–211, May 9, 1902.)—When kathode rays fall on a metallic surface, the author finds that they give rise to a species of secondary kathode rays, more deflectable than the primary. As the discharge potential and gas pressure are varied, these secondary rays go through numerous gradations, in some of which they strongly resemble the light of the positive column. R. S. W.

2081. *Theory of Spark-Telegraphy.* **A. Slaby.** (Elektrotechn. Zeitschr. 23. pp. 165–169, Feb. 27, and pp. 254–258, March 27, 1902. Abstract in the Electrician, April 25 and May 2, 1902.)—The author first gives the results of oscillation determinations, by means of a spark micrometer, in a straight wire connected to one electrode of an induction coil, the other electrode being earthed or connected to a large capacity. A standing wave was found, with potential loops at the ends and a relative node at the middle. The overtones were negligible. When the electrode was connected with any other point than the end of the wire, a disturbed wave of similar character was obtained. The results of these and other experiments are in strict agreement with those obtained theoretically by M. Abraham [see Abstract No. 285 (1899)]. The law connecting the magnitude of the effect on the receiver with the distance from the transmitter was found by means of micrometer measurements to be that of the inverse distance. With a series of Leyden jars of known capacity, forming, with a known length of wire, a closed circuit, except for the spark-gap, Kirchhoff's formula was found to be in exact agreement with the experimental results. Kelvin's formula, given in 1853, in which the effect of capacity is neglected, gave values about 36 per cent. too high—a result which was to be anticipated. The character of the sparking had no effect on the wave-length emitted. [See also Abstract No. 1015 (1901).] G. W. DE T.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2082. *Resistivity of Iron Alloys.* **W. F. Barrett.** (Roy. Soc., Proc. 69. pp. 480–485, April 4, 1902.)—In reference to the alloys mentioned in a previous research [see Abstract No. 1721 (1902)] the author traces a connection between the atomic weight of the alloying element and (1) the electrical resistivity, and (2) the specific heat of the alloy. He comes to the conclusion that, as far as his experiments go, the two properties mentioned decrease as the atomic weight of the alloying metal increases. P. E. S.

2083. *Temperature Variation of Electrical Resistance.* **W. Williams.** (Phil. Mag. 3. pp. 515–532, May, 1902. Paper read before the Physical Society.)—An attempt to show the relation of the specific electrical resistance σ for pure metals at 0° C. with the maximum chemical valency m, the atomic volume V, and the absolute melting-point T. The author shows that $\sigma = \mathrm{K}m\mathrm{V}/\mathrm{T}$, where K is a quantity that has different values for different groups of metals; from this is derived $\sigma = \mathrm{K}m\mathrm{V}\theta/\mathrm{CT}$, where $\mathrm{C} = \mathrm{V}^{\frac{1}{3}}a\mathrm{T}$, a being the coefficient of thermal expansibility, and θ the absolute temperature; this relation roughly holds for silver, copper, magnesium, sodium, zinc, cadmium, calcium, potassium, platinum, palladium, thallium, lead, mercury, arsenic, antimony, and bismuth, but fails for gold, indium, tin, and aluminium. It also fails for iron, nickel, and cobalt, while in the case of the remaining metals data cannot be obtained to test the matter. If σ is the specific resistance at temperature t, and σ_0 at 0° C., there is a temperature factor—

$$\sigma/\sigma_0 = (1 + \epsilon t)[1 + \tfrac{1}{2}(\beta' - \delta')t + \ldots];$$

this is obtained from the proportionality of q to $nh/m\lambda$, where q is the average number of electrons dissociated per unit volume, n the average number of atoms per unit volume, h the average thermal energy of an atom at temperature θ or $\rho\theta$ (ρ being the atomic specific heat), and $\lambda = \mathrm{V}^{\frac{1}{3}}a\theta$. This relation is approximately true of tin, copper, cadmium, zinc, silver, and aluminium, but not for platinum and palladium, nor for the metals of the iron group. There is a specific heat relation $\epsilon = 2.1\beta/w$; where ϵ is the average increase in the specific heat per unit rise in temperature, w the atomic weight, and β from the following relation $a = a_0(1 + \beta t)$, the relation $\epsilon = 2.1\beta/w$ is approximately true for aluminium, copper, tin, cadmium, palladium, silver, iridium, and platinum, but not for metals of the iron group; the results are uncertain for lead, magnesium, and zinc; while in the case of the remaining metals the relation cannot be tested. A further relation $\sigma_e/\sigma_s = \lambda_e/\lambda_s$, where σ_s is the value of σ in the solid state just before fusion has begun, σ_e its value in the liquid state when fusion is just completed, λ_e and λ_s being the values for λ corresponding to σ_e and σ_s. The ratio λ_e/λ_s is best calculated from the increase of volume that accompanies the fusion. This relation holds roughly true for lead, cadmium, tin, and zinc, the only metals for which, at present, it can be tested. E. C. R.

2084. *Mutual Inductance of a Circular Circuit and a Circuit with Two Parallel Infinite Straight Sides.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 11. pp. 398–406, May, 1902.)—Maxwell, in his Electricity and Magnetism, has shown how to find the mutual inductance of two circular circuits whose axes meet in a point and are inclined at an angle θ. The result is given in the form of a series whose typical term involves $P_n(\cos\theta)$, the surface zonal harmonic of nth order. The process employed by the author in the present case is identical in principle with that used by Maxwell for his circular circuits. His result is expressed in the form of a series involving the two angular co-ordinates, which determine the direction of the axis of the circular circuit relative to the two parallel sides of the other, in the form of surface sectorial harmonics. W. S.

2085. *Resistivity of Metallic Sulphide.* **J. Guinchant.** (Comptes Rendus, 134. pp. 1224–1226, May 26, 1902.)—The author endeavours to find some connection between metallic and electrolytic conduction by investigating the electrical behaviour of bodies apparently intermediate in properties—for example, the metallic sulphides, selenides, arsenides, phosphides, &c. These bodies are in general formed with slight production of heat, comparable with the heat evolution in the formation of alloys, have metallic lustre, and are, or can become, good conductors. The resistance of metals increases with the temperature, and that of electrolytic solutions decreases; conclusions as to the mode of conduction are often drawn from the sign of this temperature coefficient; but these are hardly legitimate, for certain highly-resisting alloys of copper-manganese and iron or nickel and all the metalloids have a decreasing resistance with increasing temperature. On the other hand, certain electrolytic solutions, *e.g.*, HF and H_3PO_4 have coefficients of which the sign becomes changed below 100° C. It is known that the greater number of metallic sulphides, whether natural or prepared artificially, have resistances rapidly decreasing as the temperature rises. The author has determined the resistances at different temperatures of PbS, SnS, FeS, Cu_2S, sulphide of antimony and sulphide of silver. The sulphides were obtained by precipitation, and purified from accompanying sulphur by fusion. They were cast into rods 5 mm. in diameter and 7 cm. in length. A differential method was used in measuring the resistances; the sulphide was heated in a thick copper tube in a nickel wire electric furnace. The temperatures were measured by a platinum-platiniridium couple. Thermo-electric changes had no effect. The author gives tables of the resistivities of three characteristic sulphides:—Sulphide of lead (PbS): Very good conductor at ordinary temperatures. The resistance increases as the temperature rises, and the resistivity varies almost proportionately with the temperature. From $-25°$ C. to $+100°$ C.—

$$\rho t = 0{\cdot}000298(1 + 0{\cdot}00501t).$$

The curve gave indications of a minimum resistance at a temperature probably below $-100°$ C. Stannous sulphide (SnS): Bad conductor at ordinary temperatures; resistance decreases with rise of temperature, but tends to become constant near the melting-point. From 0° C. to 100° C.—

$$\rho t = 1071(1 - 0{\cdot}00662t).$$

Ferrous sulphide (FeS): Fairly good conductor. The resistance diminishes at first until the temperature reaches 550° C.; it then increases, so that the value at 870° C. is the same as that at 200° C. The figures for FeS are as follows:—

HEATING.

t......	13° C.	90°	130°	280°	350°	495°	580°	672°	868°
ρ......	0·0998	0·0314	0·00826	0·00125	0·00102	0·00087	0·00087	0·00099	0·00171

COOLING.

t......	868°	670°	580°	465°	350°	249°	130°	95°	8°
ρ......	0·00171	0·00112	0·00099	0·00086	0·00079	0·00090	0·00605	0·0273	0·015

From 0° to 100° the resistivity is perhaps represented by—

$$\rho t = 0{\cdot}1114(1 - 0{\cdot}00798t).$$

The other sulphides studied resembled some one of the above, depending on the initial value of their conductivities. For all the velocity of variation of resistance increases continually with temperature in going from the neighbourhood of 0° C. The initial value is positive, and therefore remains positive, for good conductors; for poorer conductors it is first negative, and later changes its sign. The author concludes that "the sign of the coefficient of temperature depends on the value of the resistivity or the causes which determine it, and not on accessory phenomena, such as electrolysis, which may accompany the passage of the current." W. C. B.

2086. *Electro-calorific Effect in Tourmaline.* **R. Straubel.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 161–164, 1902.)—The experiments here described are the converse of the well-known pyroelectric phenomena observed in Tourmaline. The crystal is placed in an electric field and the thermal changes due to changes in the electric field are observed. Four plates 0·2 cm. thick were cut perpendicular to the axis of the crystal. The plates were laid one over the other in two pairs, one pair having the one pole of the crystal upwards, the other pair having the other. Between the two plates of one pair one set of junctions of a thermo-electric battery were placed, the other set of junctions being placed between the other two plates. The plates were then placed between the plates of a condenser which were 1·35 cm. apart, and could be charged to a difference of potential of 30,000 volts. On charging the condenser a deflection was observed on the galvanometer, which reached a maximum in half a minute then sank in four minutes to zero. On reversing the poles of the condenser the deflection again took place, but in the opposite direction, and again fell to zero, and so on, the deflection being repeated after each reversal. The deflections obtained averaged 4·9 scale divisions. After turning one pair of crystalline plates, so that all the plates lay with their similar poles upwards, and repeating the experiment, the average deflection only attained to 0·1 scale divisions. The temperature variation corresponding to the greater deflection was $0{\cdot}74 \times 10^{-3}$ degrees Centigrade. J. B. H.

2087. *Maxwell's Law for some Nitrogen Compounds.* **E. van Aubel.** (Comptes Rendus, 134. pp. 1050–1052, May 5, 1902.)—Schlundt has published [see Abstract No. 522 (1902)] his measurements of the dielectric constants of a number of amines (primary, secondary, and tertiary), nitro-compounds (nitromethane and nitroethane), nitrates (ethyl, propyl and butyl), and nitriles (aceto-, propio-, valero-, and capro-); the author has taken from the tables of Dufet and Loevenherz the corresponding value of the indices of refraction for the above compounds, in order to see if the relationship between dielectric constant and index of refraction was that expressed by Maxwell's law, $n^2 = k$. In all four classes of compounds it was found that the dielectric constant diminishes as the molecular weight increases, while the index of refraction increases under the same conditions. D. H. J.

2088. *Oscillographs.* **A. Blondel.** (Journ. de Physique, 1. pp. 273–302, May, 1902.)—This paper is divided into two parts, of which the first describes the new models of oscillographs, and is illustrated by nine figures. The new models described are those with a soft iron strip, and with bifilar suspension. The second part deals with the mathematical theory of oscillographs, including the cases described in the first part. [See also Abstracts Nos. 1510 (1899), 167 (1900), and 1127 (1901).] E. H. B.

2089. *Curve-Tracing Instrument.* **R. B. Owens.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 753–759, May, 1902.)—The principle of this instrument is similar to that of a differential galvanometer, but instead of a needle a coil suspended by two thin phosphor-bronze strips, and carrying a current is used. The fixed coils are simply concentric circles of wire, the current whose wave-form is to be measured being sent through one, and a direct current through the other. This latter current is adjusted until there is no deflection of the suspended coil, through which periodic impulses of current are sent by means of a contact-maker. The direct current through the fixed coil is then read by a Weston ammeter. The advantages of this instrument are: (1) It makes use of a zero method; (2) the only instrument to read is a Weston ammeter; and (3) it has very small resistance and inductance. The following applications are given: tracing p.d. and current waves, finding the curves of the growth and decay of currents, obtaining the leakage coefficients of large generators, determining the variations of the angular velocity of engine flywheels during one revolution, and finding the fluctuations of current from commutating machines. A. R.

2090. *Telephotographic Apparatus.* **A. Korn.** (Elektrotechn. Zeitschr. 23. pp. 454–455, May 22, 1902.)—The transmitter of this apparatus, like all others intended to transmit the variations of intensity of a beam of light to a distance, uses the selenium cell. The novelty of this particular apparatus lies in the receiver, which consists of a vacuum tube, the light emitted from which varies with changes made in the circuit. These changes are brought about by the transmitter, the length of a spark-gap in series with the vacuum tube and a Tesla transformer, being made to vary with the current passing through the selenium cell. The spark-gap is arranged between a fixed electrode and one which is pivoted with the needle of a galvanometer so as to turn with the needle. The current from a battery is passed through the selenium cell and the coils of the galvanometer, and so the spark-length gives a measure of current in the galvanometer and in the selenium cell. Some photographs of simple geometrical forms having two and three shades have been reproduced. J. B. H.

2091. *Sensitiveness of the Coherer.* **E. R. Wolcott.** (University Wisconsin, Bull. 3. 1. pp. 1–20, Dec., 1901.)—After some preliminary historical notes, the author describes experiments recording the diminution in the resistance of coherers of aluminium, tin, lead, zinc, iron, copper, silver, nickel, platinum, and gold. He then investigates the effect of establishing various p.d.'s between the two sections of the coherer by means of a second battery. Finally, he studies the action of the coherer when the metals are coated with non-conducting films. He arrives at the conclusions that Guthe and Trowbridge's theory explains more facts than those of Branly, Lodge, and Bose ; but that all four may be partially applicable, and that, of the above metals, aluminium is the most regular in response. The fact, observed by Marconi and others, that nickel gives the best results at long distances, he explains by the fact that it is found to have the lowest critical potential of the metals tried, and therefore responds to the smallest amount of energy, but when the intensity is sufficient to overcome the greater critical potential of aluminium, the latter gives better results than nickel, owing to the regularity of response depending on the metal itself. He therefore suggests that the best results would be attained by using a metal which shows the greatest regularity of response, coated with a medium which gives the lowest critical potential.

G. W. DE T.

2092. *Sensitive Coherer.* **E. Branly.** (Comptes Rendus, 134. pp. 1197–1199, May 26, 1902.)—The coherer consists of a tripod formed of a steel disc with three legs ending in blunt oxidised points, resting upon a polished steel disc. Decoherence is effected by the striking of the lower contact by the tongue of the relay. The tap may be very slight, and therefore the play of the tongue may be much reduced, with a corresponding increase in speed. The author finds this form very regular and reliable in action, and that it will continue in working order for several months. When transmitting a message, the tripod of the coherer at the sending station is slightly raised from the lower disc by means of an auxiliary electromagnet, and maintained in this position as long as the transmission continues. This prevents it from being effected by the transmitter sparks. [See also Abstract No. 1106 (1902).]

G. W. DE T.

2093. *Convenient Form of Vacuum Tube.* **W. B. von Czudnochowski.** (Phys. Zeitschr. 3. pp. 366–368, May 15, 1902. Also Zeitschr. f.d. physik. u. chem. Unterricht, 15. pp. 124–126, 1902.)—Some vacuum tubes made by Max Strehl are described here, which enable experimenters who are not skilled glass-blowers to study all the phenomena of kathode rays. The various electrodes are fixed to ground stoppers which fit into necks in a glass bulb, and a variety of electrodes are supplied for the standard experiments.

J. B. H.

ALTERNATING CURRENTS AND MAGNETISM.

2094. *Dielectric Constants Determined by Electric Waves.* **P. Drude.** (Ann. d. Physik, 8. 2. pp. 336–347, May, 1902, and Zeitschr. Phys. Chem. 40. pp. 635–637, May 13, 1902.)—In these determinations it is now found advantageous to introduce a Tesla transformer between the induction coil and the primary oscillator or wave generator. The whole apparatus is described and illustrated both diagrammatically and from a photograph, and is made by W. Schmidt. E. H. B.

2095. *Hysteresis Loss in a Rotating Field.* **M. Schenkel.** (Elektrotechn. Zeitschr. 23. pp. 429–430, May 15, 1902.)—The author describes an experiment which is essentially a verification of the result first obtained by Baily, and confirmed by Beattie and Clinker, and Coran and Hiecke. A laminated iron core, 35 mm. in diameter and 17·5 mm. long, was rotated on a vertical shaft between the tapered poles of an electromagnet, by means of which the induction could be forced up to 28,000. The use of an ingenious form of suspension enabled the torque due to hysteresis and eddy-currents to be separated from that arising from friction; and by running at different speeds the hysteresis torque could be separated from the eddy-current one. The hysteresis loss was found to reach a maximum at $B = 16{,}000$, and beyond this value fell with extraordinary rapidity, appearing to approach a zero value asymptotically. A. H.

2096. *Magnetic Determination of Iron-Fields.* **R. Thalén.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. 5. pp. 175–189, May, 1902.)—The author shows how to detect the situation of an iron-field by means of magnetic measurements. Let G and F denote the vertical and horizontal components of the ore-magnetism respectively, V and H the corresponding elements of the terrestrial magnetism, P the overweight attached to, say, the south end of the needle, this overweight being chosen so that the needle will be horizontal on a field containing no ores; the inclination δ of the mining-compass on the horizontal plane in the meridian will be given by the formula $\tan\delta = (V + G - P)/(H - F) = G/(H - F)$. This shows that δ will be $= 90°$ for $H = F$, which can occur only to the south or north of the south-pole of the iron-layer, but never vertically above this pole. Three different methods are then given of ascertaining the depth of the centre of gravity of the iron-layer. The rules given are next applied to a large series of measurements, the apparatus used being very fully described. A. G.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

2097. *The Effect of Electric Waves on the Human Brain.* **D. McIntosh** and **J. Graham-Willmore.** (Elect. World and Engineer, 39. pp. 952–954, May 31, 1902.)—An account of a series of experiments made to investigate the coherer-effect described by A. F. Collins [see Abstract No. 1116 (1902)] as occurring in fresh brain substance. The authors report they were unable to obtain any evidence to show that such an effect existed. Trials were made with the brains of animals before and after death, and with a human brain quickly removed from a recently dead person. H. L. J.

REFERENCES.

2098. *Three Dimensional Graphics.* **E. Hospitalier.** (Soc. Inst. Élect., Bull. 2. pp. 380–382, May, 1902.)—The author suggests, for the illustration of electrical problems depending on functions of three variables, the construction of wire models of the curves of double curvature involved. G. W. de T.

2099. *The Rectified Alternate Current.* **C. Heinke.** (Phys. Zeitschr. 3. pp. 334–336, May 1, 1902.)—This is a note on the paper on the same subject by Gerschun [see Abstract No. 1547 (1902)]. The author gives a simpler method than that of Gerschun for considering the case of a transformer fed by such a current, obtaining also some additional results. W. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2100. *Action of Hydrogen on Sulphide of Mercury.* **H. Pélabon.** (Chem. News, 85. pp. 172–175, April 11, 1902. Bull. Soc. Chim. Series, 3. 25. No. 16.) —Crystallised sulphide of mercury is slowly acted on by hydrogen at 280°. In order to study the reaction at higher temperatures, the author employed the method of rapid cooling previously described. [See Abstract No. 1732 (1902).] Excess of mercury being present, the quantity of sulphuretted hydrogen formed was found to tend towards a limit which did not depend on the pressure of the hydrogen or on the mass of the sulphide or mercury, provided that they were not entirely vaporised at the temperature of the experiment. ρ being the percentage of the partial pressure of the sulphuretted hydrogen of the total pressure, the limits of ρ, 78·67, 85·29, 92·10 were found to be reached at the respective temperatures 360°, 440°, 540°, after heating for about 90, 14, and 4 hours. If excess of mercury be not present, it is calculated that for lower pressures than 416 mm., values for ρ ought to be obtained different from those for higher pressures, as the mercury set free will be in the form of a non-saturated vapour, and this conclusion is confirmed by experiment. The results obtained afford additional evidence in support of the equation $p_1p_2/p_3p_4 = f(T)$ [see Abstract No. 1121 (1900)], and the verification can be extended by examining the action of sulphuretted hydrogen on mercury. As the sulphide formed in this case can exist in the form of a non-saturated vapour, the limit value of ρ theoretically should be lower than when excess of sulphide of mercury is present, and experimental evidence for this is adduced. W. E. T.

2101. *Surface Tension of Liquid Precipitates.* II. **G. Quincke.** (Ann. d. Physik, 7. 4. pp. 701–744, April 8, 1902.)—Oily precipitates are formed by the action of carbon dioxide and of caustic alkalies on solutions of calcium nitrate, chloride and bicarbonate, which may last from 1–3 seconds or for some hours before solidifying. It is suggested that the formation of sphærocrystals in plants is due to the intermediate formation of similar liquid precipitates. [See also Abstract No. 1574 (1902).] T. M. L.

2102. *Oceanic Salt Deposits. Formation of Loeweïte and its Lower Temperature-limit at* 43°. **J. H. van't Hoff** and **A. o'Farelly.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 19. pp. 370–375, April 10, 1902.)—Loeweïte, $Na_2Mg(SO_4)_2 . 2H_2O$, occurs in the Stassfurt salt-beds, but, like langbeinite [see Abstract No. 1748 (1902)], cannot be produced at 25°. It can be formed from astrakanite above 71°, according to the equation—

$$Na_2Mg(SO_4)_2 . 4H_2O = Na_2Mg(SO_4)_2 . 2H_2O + 2H_2O.$$

In a solution saturated with sea-salts the transition-point for these two compounds is lowered to 43°, and this is probably the lowest temperature at which loeweïte can have been deposited. T. M. L.

2103. *A Characteristic Salt in the Magdeburg-Halberstädt Salt-Beds.* **K. Kubierschky** and **J. H. van't Hoff.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 20. pp. 404–415, April 17, 1902.)—A mineral was found in the Wilhelmshall pit in the Stassfurt salt-beds which on analysis gave very irregular results; but when these results were represented graphically they showed that the mineral was a mixture of two constituents, one of which was free from potassium. By extrapolation from the observed composition of samples containing various amounts of K_2SO_4, the composition of a mineral free from K_2SO_4 was deduced, viz., H_2O — 0, $MgSO_4$ — 22, Na_2SO_4 — 78 mols. per cent. The one constituent is therefore an anhydrous salt, and has the composition $3Na_2SO_4 . MgSO_4$. For this new mineral the name Vanthoffite is proposed. The second constituent is a hydrated salt containing K_2SO_4, and may be either $3K_2SO_4 . 4MgSO_4 . 6Na_2SO_4 . 8H_2O$, or (by further subtracting $MgSO_4 . 3Na_2SO_4$ and dividing by 3) $K_2SO_4 . MgSO_4 . Na_2SO_4 . \frac{8}{3}H_2O$. In attempting to prepare the salt $MgSO_4 . 3Na_2SO_4$ synthetically a new anhydrous double salt was prepared having the composition $2K_2SO_4 . Na_2SO_4$. Vanthoffite can be prepared synthetically in two ways. (1) It is a final dehydration product of sodium magnesium sulphate; an equimolecular solution of Na_2SO_4 and $MgSO_4$ deposits at 22° crystals of astrakanite $Na_2Mg(SO_4)_2 . 4H_2O$, which changes at 70° to loeweïte $Na_2Mg(SO_4)_2 . 2H_2O$, and at a slightly higher temperature to the anhydrous salt $3Na_2SO_4 . MgSO_4$, the excess of $MgSO_4$ remaining in solution. (2) It is more readily prepared by dehydrating a mixture of astrakanite and sodium sulphate by bringing them into contact with a solution of low vapour tension, $Na_2Mg(SO_4)_2 . 4H_2O + 2Na_2SO_4 - 4H_2O = MgNa_6(SO_4)_4$; a solution saturated with astrakanite and sodium sulphate and also with sodium chloride and glaserite has the composition—

$$1000H_2O + 42Na_2Cl_2 + 8K_2Cl_2 + 16MgSO_4 + 6Na_2SO_4,$$

and affords the best method of preparing the new mineral. T. M. L.

2104. *So-called Liquid Crystals.* II. **G. Tammann.** (Ann. d. Physik, 8. 1. pp. 103–108, April 29, 1902.)—With regard to the formation of so-called liquid crystals by cholesteryl benzoate, *p* — azoxyphenetol, &c., the author reiterates the view he has previously expressed on the subject, and further points out that the existence of crystals with a displacement elasticity equal to zero would introduce a fundamental modification of the space-net theory, if it did not, indeed, require its complete abandonment. Further experiments are described which support the view that such liquid crystals must really be regarded as emulsions. [See also Abstract No. 1352 (1901).] T. H. P.

2105. *Liquid Gold Hydrosolutions.* **A. Gutbier.** (Zeitschr. Anorg. Chem. 31. 4. pp. 448–452, 1902.)—The author has obtained chemically pseudo-solutions of gold of a blue colour of great stability, by reducing dilute neutral gold chloride solutions with hydrazine hydrate solutions. Necessary precautions are enumerated, and it is pointed out that by the same method numerous elements may be transformed into the colloidal state. A. G.

2106. *The Direct Combination of Chlorine with Carbon.* **R. Lorenz.** (Zeitschr. Elektrochem. 8. pp. 203–204, April 10, 1902.)—In connection with W. von Bolton's [see Abstract No. 1758 (1902)] research on the direct combination of chlorine with carbon, the author points out that he had already, in 1888, shown that it might be a source of error in the determination of carbon in steel by the so-called Wöhler method. The steel is heated in a current of chlorine, iron chloride volatilises, and carbon is left behind as an extremely fine powder. At a red heat this very finely divided carbon combines with chlorine. Further the author has observed a direct combination in the preparation of boron trichloride by passing chlorine over a heated mixture of carbon and boron trioxide. Long white hair-shaped crystals were obtained, which had the melting-point of hexachlorbenzene. Further, a direct combination has been noticed in the electrolysis of fused halogon compounds with a suitably high temperature and current density. W. C. B.

2107. *Velocity of Reaction between Amines and Nitrous Acid.* **H. Euler.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 59. 4. pp. 111–125, April 9, 1902.)—The action of nitrous acid on aromatic amines is of the first order, while that on fat amines is of the second order, the velocity of reaction being much smaller. A. G.

2108. *Elimination of Silicon in the Acid Open Hearth.* **A. M'William** and **W. H. Hatfield.** (Iron and Steel Institute, Journ. pp. 1–11, May, 1902.)—The proportion of silicon in open-hearth steel is closely related to the percentage of silica in the slag, and this largely without reference to the percentage of carbon and manganese in the metal. A thin slag containing about 51 per cent. SiO_2 gives a very low silicon steel, a slag containing about 54 per cent. SiO_2 gives a medium steel, and a thick slag containing 57 per cent. SiO_2 gives a steel high in silicon. This conclusion was fully confirmed by two experimental "heats" in which the proportion of silicon was first reduced in contact with a thin slag, was then allowed to rise as the slag took up silica from the hearth and thickened, and finally was again reduced by the addition of basic material to the slag; in each case the percentage of carbon was steadily falling during the whole "heat." A rise of temperature appears to favour the retention of silicon by the iron, but this is very possibly due to the increasing absorption by the slag of the silica of the hearth. T. M. L.

2109. *Behaviour of Oxygen and Hydrogen in presence of Water.* **A. Marcacci.** (Accad. Lincei, Atti, 11. pp. 324–326, April 20, 1902.)—In the present preliminary note it is shown by simple experiments in which the gases are confined over water, that oxygen and hydrogen combine at the ordinary temperature in presence of water. Some experiments leading to the same conclusion were announced to the International Physiological Congress at Turin in September, 1901. D. H. J.

2110. *Permeability of Animal Membranes.* **G. Galeotti.** (Zeitschr. Phys. Chem. 40. pp. 481–497, April, 1902.)—Animal membranes in contact with solutions vary in the readiness with which they permit the passage of dissolved substances in one direction or another. For the study of the subject the author chose the method of examining the change of resistance of an electrolytic cell due to the introduction of the membrane midway between the electrodes. The electrolytic cell was made in two parts, each part consisting of a piece of glass tubing (5 cm. long and 14 mm. through) sealed at one end and open at the other; the open ends were ground so as to fit closely together to form the complete cell. Platinum electrodes of nearly the same diameter as the cell were placed at ½ cm. from the ground surfaces. Resistances were determined by Kohlrausch's telephone method. For each solution (common salt, potassium oxalate, &c.) the resistance of the filled electrolytic cell was first determined; the membrane was then placed on a silver ring and the ring was slipped over the end of one half of the cell; the ground end of the other half of the cell was then brought against the membrane and the resistance was again determined; the determination was repeated at intervals. In order to study dead membranes the latter were, in many cases, exposed on the silver ring to chloroform vapour; the membranes showed microscopically no sign of structural alteration. The membranes employed were from (*a*) sheep intestines (freed from fat by treatment with ether, alcohol, and water), (*b*) the pericardium of the dog, (*c*) the mesenterium of the rabbit, (*d*) the bladder of the tortoise, (*e*) the cœcum of the rabbit, (*f*) holothuria intestines. The solutions used were equivalent, and also approximately isotonic with the solutions which naturally come in contact with the membranes. The experiments show that inactive membranes (*a*) offer but little resistance to the passage of the different ions, and the permeability does not alter by contact with the solution. Living membranes of a structure such as we find in the mesenterium and pericardium, (*b*) and (*c*), also show considerable permeability, which is little affected by the death of the cells; these membranes act merely like ordinary diffusion membranes, and, in accordance with their natural functions, do not possess the property of resisting the forces which determine the migration of the ions. Other living membranes, which consist of specifically differentiated epithelial cells, and are destined to live in solutions varying in kind and in concentration, behave differently with different electrolytes; some membranes favour the passage through the cell protoplasm, others oppose it. This selective action is a specific property of the living cell, and disappears with the death of the cell (either from the poisonous action of the solution or by the action of chloroform). The author gives a bibliography of recent work. D. H. J.

2111. *Densities of Mixtures of Hydrazine and Water.* **J. W. Dito.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 838–840, April 19, 1902.)—An investigation of the densities of mixtures of hydrazine and water was particularly interesting, as it results from Curtius's researches that hydrazine, when separated from aqueous solutions of its salts by the action of bases, will always be fixed on water, distillation giving a definite hydrate corresponding with the formula $N_2H_4 - H_2O$. The author tests the whole of the system hydrazine + water, it being shown that the curve of densities presents a maximum corresponding to the composition $N_2H_4 - H_2O$. The analogy with the behaviour of the system $SO_3 + H_2O$, as studied by Knietsch, is pointed out, contraction taking place in both cases on solution. A. G.

2112. *Union of Hydrogen and Oxygen.* **H. B. Baker.** (Chem. Soc., Journ. 81. and 82. pp. 400–406, April, 1902.)—The recognition of the fact that moist hydrogen and oxygen slowly combine in sunlight, made it advisable for the author to repeat some of his experiments on the union of dry hydrogen and oxygen, since it is conceivable that in the former experiments, in which the mixed gases were dried in the light, the rate of the continued production of water in the light might be equal to the rate of its absorption by the drying agent. In the present experiments specially pure hydrogen and oxygen were obtained by the electrolysis of barium hydrate, and the mixed gases were dried in the dark. It was found that the dried gases undergo no change in sunlight or at the melting-point of silver, and do not explode on heating to redness. There is no contraction observable on drying a gas from the point at which moisture ceases to exert any measurable tension to the point at which the gas ceases to be chemically active; this was verified for hydrogen, oxygen, nitrogen, air, and for a mixture of hydrogen and oxygen, so that the dissociation of gases in the undried condition, if it exists, is too small to be detected by volume measurements. D. H. J.

2113. *Stability of the Equilibrium of Univariant Systems.* **P. Saurel.** (Journ. Phys. Chem. 6. pp. 257–260, April, 1902.)—Proofs are given of the following two theorems due to Roozeboom: I. Consider at the temperature and pressure of a multiple point a reversible variation which *increases* the entropy of the invariant system, the volume remaining constant. If during this process the mass of the *i*-th phase *increases*, then that invariant system in which the *i*-th phase is lacking cannot exist in stable equilibrium at temperatures *higher* than the multiple point. If the mass of the *i*-th phase *diminishes*, then the invariant system which does not contain this phase cannot exist at temperatures *lower* than that of the multiple point. II. Consider similarly a reversible variation in which the volume of the invariant system *diminishes*, the entropy remaining unchanged. If the mass of the *i*-th phase *increases*, then the corresponding invariant system cannot exist in stable equilibrium at pressures *higher* than that of the multiple point; if it *diminishes*, then the corresponding invariant system cannot exist at pressures *lower* than that of the multiple point.

F. G. D.

2114. *Equilibrium Between a Solid and its Saturated Solution at Various Temperatures.* **J. S. Lumsden.** (Chem. Soc., Journ. 81. and 82. pp. 363–372, April, 1902.)—The solubility-curve of calcium propionate, which is convex to the axis of temperature, is regarded as exhibiting the typical form. The factors which determine solubility are stated to be three: (1) The thermal energy of the solid increasing rapidly as the temperature rises; (2) the affinity between solvent and solute, decreasing as the temperature rises; and (3) the opposing force of osmotic pressure, increasing as the temperature rises. These are represented in a diagram, and the resultant is a solubility curve similar to that of calcium propionate. The heat of solution of a solid usually decreases as the solution becomes more concentrated, and if positive in dilute solution may become zero and finally negative in a concentrated solution; the heat of solution of a solid in a supersaturated solution may be determined by noting the heat absorbed or liberated in the reverse process of crystallisation from the supersaturated solution. Experiments with calcium propionate (+ $1H_2O$) showed that at 12·4° the addition of successive quantities of 2½ grams of the salt to 25 grams of water produced a rise of temperature of 3·5°, 2°, 1·4°, 0·9°, and 0·6°. The heat of solution also diminishes usually with rise of temperature. At 10° the dissolution of 10 g. calcium propionate in 25 g. water raised the temperature 9·2°, whilst at 85° the rise of temperature was less than 1°.

According to the views put forward a solubility increasing or decreasing continuously with temperature represents a case in which only one branch of the solubility curve lies within the limits of experiment, and if the proper experimental conditions could be reached every curve would exhibit a minimum. A curve concave to the axis of temperature, and exhibiting a temperature of maximum solubility, is probably impossible; such concave curves have occasionally been described, but probably in each case the intersecting convex curves of two hydrates have been mistaken for a single curve, the point of transition being overlooked. This has been found to be true for barium acetate and calcium isobutyrate, which have been stated to give solubility curves concave to the axis of temperature. T. M. L.

2115. *Comparative Study of Low-Carbon Steel Alloys.* **J. A. Mathews.** (Iron and Steel Institute, Journ. pp. 1–40, May, 1902.)—An iron was prepared by melting bar-iron ($C = 0·4$ per cent., $P = 0·0066$, $Si = 0·068$, $S = 0·0056$, Mn = 0·025) with hæmatite, and on analysis gave C = 0·035 per cent., Si = 0·093, P = 0·0093; it was thus almost free from carbon, and contained only traces of other substances. Alloys of this iron were prepared by melting with chromium, manganese, molybdenum, tungsten, and nickel; in almost every case the resulting alloys contained less than 0·2 per cent. of carbon.

The dissolution of the iron in 10 per cent. hydrochloric acid is hindered by alloying with Cr and Ni and most of all by Mo. The tensile strength and elastic limit of the iron are increased by the addition of nickel, more so by the addition of chromium, and most of all by the addition of molybdenum; annealing reduces the T.S. (especially of the high-chromium alloys) and elastic limit, but increases the elongation and reduction per cent. of the test-pieces. The conductivity measurements gave results in general agreement with those of Barrett, Brown, and Hadfield, but in accordance with the greater purity of the materials used the conductivities observed were higher throughout. T. M. L.

2116. *Thallium-Sesquioxide Alums.* **A. Piccini** and **V. Fortini.** (Zeitschr. Anorg. Chem. 31. 4. pp. 451–454, 1902.)—The authors have succeeded in obtaining perfectly homogeneous mixture crystals of ammonium alum where part of the aluminium is substituted by thallium, this substitution occurring at variable ratios. They state that aluminium under anomalous conditions will give some compounds given by thallium under normal conditions. Indium, in this respect, also shows an intermediate behaviour. These experiments tend to confirm the perfect analogy between those elements, which consequence of the periodic system has recently been questioned by Locke. [See Am. Chem. Soc. Journ. 27. p. 280, 1902.] A. G.

2117. *Decomposition of Mercurous Chloride by Dissolved Chlorides.* **T. W. Richards** and **E. H. Archibald.** (Zeitschr. Phys. Chem. 40. pp. 385–398, April, 1902.)—In presence of hydrogen chloride or metallic chlorides, mercurous chloride is converted into mercuric chloride and so brought into solution in the manner expressed by the equation $Hg_2Cl_2 = HgCl_2 + Hg$. In solutions of equivalent strength hydrogen chloride and sodium chloride have approximately the same effect, barium chloride is less active and calcium chloride produces practically no effect. The amount of mercury dissolved increases with the concentration of the soluble chloride, but reaches a maximum at about 7 equivalents per litre of calcium chloride or 8 equivalents of hydrogen chloride. The influence of the soluble chloride may be explained by supposing that a double salt or mercurichloride is formed similar to the platinichlorides; this may be more or less ionised in accordance with an equation such as—

$$2NaCl + HgCl_2 \rightleftarrows Na_2HgCl_4 \rightleftarrows 2\overset{+}{Na} + \overset{-}{H}g\overset{-}{C}l_4,$$

whilst if entirely ionised its formation might be represented by the simple ionic equation $2\overset{-}{Cl} + HgCl_2 = \overset{-}{H}g\overset{-}{C}l_4$ or $2\overset{-}{Cl} + Hg_2Cl_2 = Hg + \overset{-}{H}g\overset{-}{C}l_4$. The facts are best explained by supposing that the double salt is only partially ionised. The corresponding reaction takes place to a still greater extent in the case of the bromides and iodides, but not in the case of the sulphates. T. M. L.

2118. *Transference of Polarisation through Metallic Plates.* **W. Nernst** and **A. Lessing.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2.

pp. 146–160, 1902. From the Universitäts-Institut für Physik. Chemie at Göttingen.)—The authors have investigated the question whether oxidising and reducing agents can exert their actions through platinum and palladium plates. It was possible that such action, if it existed, might escape detection by chemical means, and the authors therefore conducted experiments (similar to those of Root and Helmholtz in 1876) in which the change of potential on the outer side of the metal plate was examined from time to time after polarisation. From these experiments it appears that (1) if a reduction-potential is communicated (by electrolysis, by direct action of hydrogen gas or of a reducing agent) to one side of a palladium plate, the hydrogen with which the plate is charged migrates through the plate: such migration is governed by the laws of diffusion; (2) for oxygen no such diffusion could be detected; (3) with platinum there was no diffusion either of oxygen or hydrogen. D. H. J.

2119. *Voltaic Polarisation.* **Berthelot.** (Comptes Rendus, 134. pp. 865–873, April 21, 1902).—The author discusses electrolytic decompositions in which secondary reactions, independent of the electrolysis, take place. Experiments are described which show that the oxygen of the air exerts no immediate influence on the polarisation. In liquids to which pyrogallol has been added, the absorption of the atmospheric oxygen does not play an appreciable part in the production of the electromotive force which results entirely from the internal chemical reactions of the cell; this is, however, not quite the case if the liquid is violently shaken up in presence of oxygen. The effects produced by the addition of compounds of an acid nature, such as phenol, are also discussed. T. H. P.

2120. *Retrograde Diffusion of Electrolytes.* **J. Thovert.** (Comptes Rendus, 134. pp. 826–827, April 14, 1902.)—If we allow a solution of an acid to which another electrolyte has been added, to diffuse in presence of a quantity of this additional electrolyte, we find that the added electrolyte, though distributed at first uniformly through the whole liquid, becomes unevenly distributed after the experiment has proceeded for some time, The following table gives the details of the experiments, which were conducted in diffusion cylinders. At the end of an experiment the contents of the cylinder were removed in three separate portions (upper, middle, and lower) and analysed:—

Acid.	Added Salt.	Duration of Experiment.	Concentration of	In thirds.		
				Upper.	Middle.	Lower.
0·4HCl	0.39NaCl	16 h.	NaCl	0·384	0·390	0·395
,,	,,	47	,,	0·373	0·380	0·405
1HCl	0·39KCl	47	KCl	0·363	0·392	0·413
,,	,,	143	,,	0·350	0·401	0·425
0·5HNO_3	0·5$AgNO_3$	10	$AgNO_3$	0·48	0·49	0·52
,,	,,	50	,,	0·47	0·49	0·54
½H_2SO_4	1·03HCl	52	HCl	1·07	1·01	0·98

These results are explicable by Nernst's electrolytic theory of diffusion. If, in addition to the diffusing body, HCl, for instance, there is another uniformly distributed body—say, NaCl—present, we get diffusion as usual, in consequence of osmotic pressure, but the compensating electric force acting on the ions of the added electrolyte will be less than if the HCl alone were present. Consequently there will be an increase of speed for the H ions (as shown experimentally by Arrhenius) and a retrogradation of the Na ions as shown above. D. H. J.

2121. *Manufacture of Caustic Soda and Bleaching Powder.* **J. G. A. Rhodin.** (Elektrochem. Zeitschr. 9. pp. 4–7, April, 1902. From the "Teknisk Tidschrift.")—The paper forms part of an address delivered by the author to the Society of Swedish Technologists, and contains an account of the author's arrangement (patented in England in 1896 and in Sweden in 1897) for the electrolysis of sodium chloride and the subsequent production of sodium hydrate and bleaching powder. The apparatus consists of an inner vessel, containing the salt solution floating on mercury; the mercury is in communication with an outer vessel containing water. The mercury forms the negative electrode, so that the sodium liberated during electrolysis first forms sodium amalgam, which by agitation is brought into contact with the water in the outer vessel; sodium hydrate free from chloride is thus obtained in the outer vessel, whilst chlorine is given off from the anode placed in the inner vessel. The author, after pointing out that the present supply of sodium hydrate and bleaching powder does not keep pace with the demand, gives details of working expenses to show that the present process is financially satisfactory. D. H. J.

2122. *Alternate-Current Electrolysis.* **E. Wilson.** (Electrician, 48. pp. 1025–1026, April 18, 1902.)—As alternate currents are employed in rail-returns for electric traction, the investigation of the electrolytic effects of alternate currents has become of practical importance, especially in the case of lead, which is extensively employed in underground work. An alternating current of density 0·024 amperes per sq. cm. and frequency 89 per second was passed for seven hours between two parallel plates of commercial lead 0·317 apart, immersed in dilute sulphuric acid. At the beginning of the experiment, while the plates were still bright, a curve of the potential difference was obtained between one of the plates and an exploring platinum electrode introduced halfway between the plates; simultaneously a curve of current was obtained by finding the instantaneous value of the potential difference between the ends of a non-inductive resistance placed in the circuit. These observations were repeated at the end of the experiment, using the same frequency, and the results plotted as a cyclical curve, the area of the curve representing the work spent upon electrolytic hysteresis, as, with the current densities employed, the potential difference due to conductivity of the electrolyte is negligible. A curve of similar form was obtained for frequency 23·3 per second, and current density 0·007 amperes per sq. cm. The ratio of the area of the first curve to that of the second was 0·854 to 1. A considerable amount of $PbSO_4$ was formed, so that the experiments were repeated with pure lead plates, using a current of 0·024 amperes per sq. cm. and frequencies 92·5 and 21·5. The diminution in weight was nearly twice as great at the lower frequency as it was at the higher, and the cyclical curves were of the same form, and the ratio of their area 0·22 to 1. This shows that frequency plays an important part in the reaction; the effect is entirely due to the current, as plates immersed in the same electrolyte when no current is passing are only slightly discoloured. Experiments were also conducted with aluminium plates in a solution of alum. The effect of the film of basic aluminium sulphate formed is very marked with alternating currents [see Abstract No. 1358 (1898)]. Two aluminium and two iron plates of equal areas and the same distance apart were placed in alum solutions of equal strengths, with a current of frequency 17 and density 0·0169 amperes per sq. cm.; the maximum volts between the aluminium plates were 46, and between the iron plates 1·3.

A table of results is given :—

Data from Curves.	Commercial Lead.	Pure Lead.	Pure Lead.
Frequency in periods per sec....	89·0	92·5	21·5
(1) At beginning of experiment :—			
Max. coulombs	0·0095	0·0094	0·0394
Energy dissipated per plate per period in joules	0·0226	0·021	0·1122
Average watts per plate.........	2·13	1·94	2·42
(2) At end of experiment :—			
Max. coulombs	0·00947	0·0090	0·0406
Energy dissipated per plate per period in joules	0·0226	0·0316	0·1245
Average watts per plate.........	2·13	2·92	2·68

W. C. B.

2123. *Alkaline Earth Arsenides.* **P. Lebeau.** (Annal. Chim. Phys. 25. pp. 470–483, April, 1902.)—Arsenides of the metals of the alkaline earths of the type AS_2R_3 are readily obtained by the reduction of the corresponding arsenates by means of carbon in the electric furnace. These compounds are hence possessed of great stability, and are also very active chemically.

T. H. P.

REFERENCES.

2124. *Influence of Dissolved Salts on the Vapour Pressure of Aqueous Ammonia Solution.* **E. P. Perman.** (Chem. Soc., Journ. 81. and 82. pp. 480–489, May, 1902.)—[See also Abstract No. 1738 (1901).] D. H. J.

2125. *Physical Constants of Telluretted Hydrogen.* **de Forcrand** and **Fonzes-Diacon.** (Comptes Rendus, 134. pp. 1209–1212, May 26, 1902.) D. H. J.

2126. *A New Induced Oxidation.* **A. Job.** (Comptes Rendus, 134. pp. 1052–1054, May 5, 1902.) D. H. J.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

2127. *Breaking of Shafts at Critical Speeds.* **J. Frith and E. H. Lamb.** (Inst. Elect. Engin., Journ. 31. pp. 646–667, March, 1902.)—Various cases are on record of the failure of engine and dynamo shafts at some particular speed, which could not be explained by the effect of ordinary working strains, and suggested that the free period of some oscillations of the crank-shaft together with the attached masses, synchronised with the period of some external periodic force acting on the system. The authors show that absolute synchronism of these two periods is not essential to produce fracture, but that when the two periods approach within certain limits, there is great risk of fracture. They also show that the fractures can be avoided by a suitable adjustment of the stiffness of the shafts, and by some alteration in the moments of inertia of the revolving masses. A number of cases are investigated and solutions worked out in the paper and an appendix. The authors point out that an exact calculation of the periods of free motion is impossible, and recommend that in the design of plants these calculations should be applied to the shafts; and, in the event of the results giving periods of at all the same magnitude as the period of the engine beats, the shafts should be properly stiffened until all chance of synchronism is out of the question, and the forced amplitudes, which exist under all conditions, become small enough to produce no injurious effects. G. W. de T.

2128. *Torsional Vibrations of Shafts.* **L. Gümbel.** (Inst. Naval Architects, Trans. 41. pp. 138–153, 1902. See also Engineering, April 11, 1902.)—In this paper, which was inspired by the one referred to in the preceding Abstract, the author, after referring to the work of Bauer [Jahrbuch der Schiffbautechnischen Gesellschaft. 1. 1900], Lorenz [Dynamik der Kurbelbetriebe, Leipsic, 1901], and Frahm [Verhand. der Gesell. deutscher Naturforsch. und Aerzte, Hamburg, 1901], applies Fourier's analysis to the problem, on the assumption of a proportionality between turning moment and angular velocity which is always applicable in the case of engine-driving dynamos, as well as in the case of marine and most other engines. The conclusions drawn from the results of the investigation are that: (1) The force with which the engine acts on the shaft should be kept as uniform as possible. (2) The continued application of revolutions of the engine which bear a simple ratio to the frequency of the natural vibration of the shaft should be avoided. (3) The possible tangential force diagrams should be determined for that number of revolutions likely to be adopted in practice which is most exposed to vibration; and it should then be ascertained, by the aid of the simple formulæ given in the paper, whether the resulting distortion of the shaft will remain within admissible limits. G. W. de T.

2129. *Construction and Inspection of Steam Boilers.* (Frank. Inst., Journ. 153. Discussion, pp. 321–340, May, and pp. 431–450, June, 1902.)—This discussion was principally confined to the causes of the explosion of the loco-type boiler in the steamer *City of Trenton,* the questions of inspection and of construction of steam boilers generally not being dwelt upon. S. M.

Vauclain held that the accident was caused by overheating of the crown sheet from shortness of water, the flame having been directed upon one portion of that plate by a bridge. The overheated part sagged between the the stay-bolts, disengaging the screw threads by which they held up the plates, and throwing the strain on the rivet heads, which could not support it. **W. B. le Van** opposed that view, and maintained that the elongation of the stay-bolt holes and stripping of the threads were effects and not causes of the explosion, and that the threads were of too coarse a pitch originally. **J. M. Hartmann** blamed the faulty construction of the stay-bolts, and suggested improvements. **R. D. Kinney** suggested that the steamer having a list to one side would account for a portion of the crown plate being denuded of water long enough to become overheated, the position and appearance of the safety plug favouring this view. **G. B. Hartley** instanced the collapsing of furnace flues in marine boilers from overheating (although there was no shortness of water) caused by a coating of oil becoming deposited on the plate surfaces, and elicited the fact that oil was present in the *City of Trenton's* boilers. **S. M. Vauclain** made some suggestions for an improved construction of the boiler, and **J. M. Hartmann** advanced some reasons for alteration of the existing procedure in boiler inspection. F. J. R.

2130. *Pulverised Fuel for Power Plants.* **F. G. Gasche.** (Railroad Gazette, 34. pp. 466–467, June 20, 1902.)—The author maintains that only the cost of pulverising has hitherto hindered the economical use of powdered fuel, but that modern methods have greatly improved that aspect of the industry. [See Abstracts Nos. 2232 (1901) and 543 (1902).] Results of comparative tests with the same coal used in hand-fired and dust-fired boiler furnaces are given in tables, and show 71·8 per cent. efficiency of boiler and furnace with dust fuel and 52·2 per cent. for hand firing.

The saving in fuel required to evaporate 5,175 lbs. of water from and at 212° F. was 10·75 per cent. by the dust-fuel method. F. J. R.

2131. *Losses from Back Pressure in Exhaust Steam-heating Systems.* **R. L. Gifford.** (Eng. News, 47. p. 453, June 5, 1902.)—The economical use of exhaust steam for heating buildings is limited by the amount of back pressure put upon the engine. One instance is quoted of an engine which developed 300 h.p. from 80 lbs. boiler pressure, or about 35 lbs. mean effective pressure at one-fourth cut-off, there being 8 lbs. back pressure caused by the heating system. In the absence of that back pressure 389 h.p. could have been obtained, so that the loss of power due to back pressure was 23 per cent. An equivalent quantity of live steam, if used direct in heating pipes, could have heated a six-storey building 75 ft. by 100 ft. in severe weather. If the steam could be circulated through the pipes at atmospheric pressure, the loss would be avoided, and even the effects of a condenser could be realised at times. These losses can be avoided by proper designing and ample pipe area. F. J. R.

2132. *Feed Regulator.* **D. Bellet.** (Locomotion Automobile, 9. pp. 394–395, June 19, 1902.)—A combined fuel and water regulator for steam boilers is described. It consists of a cylinder with a piston and vertical piston rod, the lower portion of which is coned and passes through a cone-seated hole in the cylinder cover leading to a chamber closed by a gland round the piston at its upper end. The feed-water is pumped into the cylinder above the piston and normally passes up through the cone-seated hole around the piston,

thence into the chamber above the cylinder and out through a ball valve into the boiler. By means of a branch pipe the boiler is also in connection with the portion of the cylinder below the piston, and by means of a system of levers actuated from the piston rod, the position of the piston is caused to control the fuel supply to the boiler furnace. If too much water is being pumped the piston is depressed and more fuel passes to the furnace, the boiler pressure rises and also the pressure below the piston of the regulator cylinder, which, being again forced upwards, closes the water passage round the piston rod and reduces the fuel supply until equilibrium is again restored.
C. R. D'E.

2133. *Fuel Calorimeter.* **C. R. Darling.** (Engineering, 73. p. 801, June 20, 1902.)—This is put forward as an improvement on Lewis Thompson's calorimeter, whilst providing an accurate apparatus less expensive than Mahler's. It has the advantages of electric ignition, of ingenious distribution of the resultant gases so that they are detained in contact with the water, and of rendering the combustion visible if desired, whilst giving constant results within 1 to 2 per cent. of error. The illustrations which accompany the article give a clear idea of the construction of the apparatus. [See also Abstract No. 542 (1902).]
F. J. R.

GAS AND OIL ENGINES.

2134. *Ignition for Gas Engines.* **H. Mensforth.** (Mech. Eng. 9. pp. 621–625, May 10, 1902. Paper read before the Sheffield Society of Engineers and Metallurgists, April 28, 1902.)—With mechanically uncontrolled tube ignition, the point of ignition depends: (1) on the compression, (2) the speed of the engine, (3) the length and diameter of the tube, and (4) the temperature and distance of the incandescent portion from the combustion chamber. Up to 10 h.p. this system gives fairly satisfactory results. Its drawbacks are: (i.) its liability to pre-ignition when starting the engine; (ii.) when renewing a tube the new one may not be exactly the same as the one removed; and (iii.) the Bunsen burner cannot be relied upon to always heat the tube in the same position. The chief desiderata are: (1) that the risk of pre-ignition shall be a minimum; (2) long life for the tube and easy renewal; (3) a certain amount of adjustment, when running, of the time of ignition; (4) protection from damage in the case of a tube bursting; (5) the heated portion of the tube must be near enough to the combustion chamber to insure the prompt propagation of the flame into the charge; (6) if the ignition is controlled by a valve this should open rapidly as fully as possible; (7) the ignition port should be near to the opening for incoming charges in order to insure a circulation through it; (8) the Bunsen burner must heat the tube to a bright red and the gas supplying it must not be influenced by the suction of the piston on the gas mains.

Blast-furnace gas is often so poor that it will not burn under steam boilers. As it is expelled from the furnace it has a sensible temperature, giving in thermal units 5·7 B.Th.U. and a calorific value of 54 B.Th.U. per cubic ft. When cooled it has a 100 B.T.U., and when compressed to 7 or 8 atmospheres its thermal value is 430 B.T.U. per cubic ft. For this poor gas special ignition arrangements are essential, requiring (1) an exceedingly high temperature, (2) the area of (igniting) incandescence to be adequate and well sustained. Mixed gas and air under pressure enable any desired heat on the ignition tube to be got for the ignition with satisfactory results. Faulty ignition is not always due to the ignition gear proper, one cause of late ignition is the presence of water in the cylinder. An examination of the exhaust-valve head will show the presence of water, as in such a case it will be coated with red oxide instead of being quite black. Oatmeal thrown in the tank supplying the jacket will cure some cases of leaking in the cylinder. Pre-ignition is often caused by some deposit in the cylinder becoming heated by the working of the cylinder. This is usually traceable to either tar in the gas, carbonisation of the lubricating oil, or foreign matter in the air inlet pipe, and this, getting hot, will cause pre-ignition. M. O'G.

2135. *Gas-Engine Temperatures.* **H. E. Wimperis.** (Engineering, 73. pp. 833–834, June 27, 1902.)—The author quotes F. W. Burstall's researches on gas engines and J. E. Petavel's on the emissivity of platinum at high temperatures and in gases at high pressures [see Abstract No 305 (1902)] and thinks that a variation of specific heat with temperature would explain the apparent gain of heat by the charge after the instant of highest temperature, which is usually attributed to a continuance of the combustion after that point. H. R. C.

2136. *Gas-Engine Exhaust Calorimeter.* **A. Staus.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 649–650, May 3, 1902.)—The author describes in this article the constructional details of the calorimeter devised by him, and used for measuring the heat, or its energy equivalent, left in the exhaust gas of gas motors. The author made an experiment with an old 4-h.p. gas engine (Otto type), and shows that very accurate results can be obtained. Means are provided of measuring the temperature of the exhaust gas when entering and leaving the calorimeter, and also the temperatures at entrance and exit of a stream of water which is sprayed into the calorimeter. The heat is determined by measuring the water and the rise of temperature. The gas is mixed thoroughly with the water before leaving the calorimeter. The amount of gas used by the motor during the experiment being measured, its heating value determined, and measuring also the amount of water flowing through the cylinder jacket, and the difference of temperatures in entering and leaving the jacket, the balance of heat left in the exhaust gas can easily be determined. Numerical results are given. L. G.

2137. *Aster Motors.* **L. Fournier.** (Locomotion Automobile, 9. pp. 374–377, June 12, 1902.)—The mechanical features of the water-cooled types of Aster petrol motors are described and illustrated. They are of the standard four-cycle type with vertical cylinders, automatic inlet and mechanically operated exhaust valves and fitted with high-tension electric ignition. The cylinder heads and bodies form separate castings, special attention having been given to the water-cooling of the cylinder head. In the electric ignition a positive cam action is employed for making and breaking the circuit to the induction-coil. C. R. D'E.

AUTOMOBILISM.[1]

2138. *Tests of Motor Cars.* (Automobile Club Journal, 4. pp. 15, 92, and 94, Aug. 28, and pp. 222–227, Oct. 9, 1902; Supplement.)—The results of the Automobile Clubs Reliability Trials are indicated by the number of marks given in the following table :—

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

General Description.	Price.	1. Reliability. Maximum marks, 300 per day, for 6 days.	2. Hill Climbing.		3. Condition. Maximum marks, 500.	4. Steering. Maximum marks, 250.	5. Brakes. Maximum marks, 250.	6. Horse-power and Weight. Marks.	GRAND TOTAL.	Speed on Hills. Miles per hour.	
	£	Total.	River Hill.	Westerham Hill.						River.	Westerham.
3-*h.p. chain-driven Humber Bicycle*	60	1795	418	—	430	250	250	125	3268	21·1	—
2-h.p. chain-driven Humber Bicycle	50	1727	—	—	325	200	250	—	2502	—	—
5-h.p. Century Tandem*†	145	1790	137	—	500	250	125	68	2870	9·8	—
5-h.p. Baby Peugeot	150	1799	125	130	425	250	250	64	3043	9·3	7·3
1¾-h.p. Ormonde Bicycle	42	1724	—	—	225	250	250	—	2449	—	—
5½-*h.p. Locomobile*	200	1686	57	61	400	250	200	98	2752	15·1	12·2
5½-*h.p. Locomobile*	200	1736	47	42	450	250	150	80	2755	13·0	8·9
7-h.p. Star	300	1718	35	38	300	200	200	77	2568	5·3	4·3
5½-h.p. Locomobile	300	1382	39	35	350	250	150	73	2279	12·2	8·3
5½-h.p. Locomobile	300	1780	36	39	440	250	150	86	2781	13·5	10·9
4½-h.p. Renault	245	1624	55	—	485	250	250	49	2713	7·4	—
8-*h.p. M.M.C. Voiturette*	255	1751	52	60	500	250	250	116	2979	6·7	5·8
6-h.p. De Dion Bouton*	245	1735	84	87	440	250	200	110	2906	9·9	7·6
6-h.p. White Steam Car	300	1722	53	32	500	250	125	67	2749	11·3	5·1
6-h.p. White Steam Car*	300	1800	53	63	500	250	125	72	2863	10·2	9·2
10-h p. Georges Richard	360	1481	45	—	—	250	—	115	—	8·3	—
9-h.p. James and Browne	400	1776	40	47	465	250	200	108	2886	7·3	6·4
12-h.p. Gladiator	400	1789	48	23	500	250	50	125	2785	9·2	4·6
10-h.p. Brooke	395	1774	25	32	480	250	250	88	2899	5·5	5·3
Light car fitted with Simm's 8-h.p. motor	375	1526	47	—	0	250	0	99	1922	7·2	—
10-h.p. Wolseley	380	1651	43	53	495	250	250	121	2863	—	—
7½-h.p. Wolseley	325	1785	28	—	500	250	200	100	2863	7·5	—
10-*h.p. Wolseley*	380	1795	49	61	500	250	200	127	2982	8·2	7·6
12-h.p. Belsize	385	1795	40	39	475	250	200	87	2886	6·8	5·7
9-h.p. New Orleans	315	1794	53	51	485	250	200	117	2950	8·8	7·0
8-h.p. De Dion Bouton*	328	1768	51	46	500	250	250	113	2978	8·3	6·5
8-h.p. Clement	365	1678	31	—	425	250	250	43	2677	6·1	—
10-h.p. Decauville	410	1770	25	31	440	240	250	119	2875	7·3	6·7
12-h.p. Gladiator	500	1643	40	42	495	250	50	149	2669	10·8	8·4
10-h.p. Ariel	450	1648	40	32	480	250	250	115	2815	8·7	6·5
12-h.p. Century	420	1452	66	59	240	150	0	110	2077	8·7	6·2
10-h.p. M.M.C.	450	1734	24	31	415	240	200	100	2744	6·0	5·8
7½-h.p. Germain*	450	1791	25	24	490	250	250	78	2908	6·1	4·5
6-h.p. Gardner-Serpollet	600	1713	38	33	495	250	150	204	2883	16·7	10·9
6-h.p. Gardner-Serpollet*	600	1761	44	32	500	250	150	196	2933	16·2	8·8
10-*h.p. Peugeot*	600	1793	56	42	475	250	250	173	3039	13·9	7·8
12-h.p. Brush	550	1634	25	5	465	250	200	108	2687	8·5	1·3
12-h.p. Humber	700	1794	26	30	470	250	200	111	2881	7·8	6·9
20-*h.p. Wolseley*	650	1800	34	41	495	250	200	193	3013	13·7	12·5
8-h.p. Wilson and Pilcher†	650	1787	26	10	500	250	250	101	2924	8·3	2·3
15-h.p. Germain	700	1797	36	40	465	250	200	167	2955	12·3	10·2
16-h.p. Clement	700	1574	29	35	130	250	250	197	2465	12·4	11·3
12-h.p. Daimler*	750	1786	28	30	475	250	250	165	2984	9·7	7·7
20-h.p. M.M.C.	800	1495	20	6	250	250	250	132	2403	10·7	2·5
20-h.p. Maudslay*	840	1797	26	27	500	250	200	115	2915	9·5	7·3
20-h.p. Pascal	860	1716	28	25	450	250	200	170	2848	15·3	10·5
20-*h.p. Pascal*	860	1780	22	28	475	250	250	132	2937	8·7	8·3
22-h.p. Daimler*	1150	1792	28	33	500	250	250	181	3034	13·0	11·6
22-h.p. Daimler	1150	1663	21	—	500	250	150	208	2792	13·7	—
15-*h.p. Panhard*	1150	1799	41	37	500	250	250	208	3085	16·5	11·3

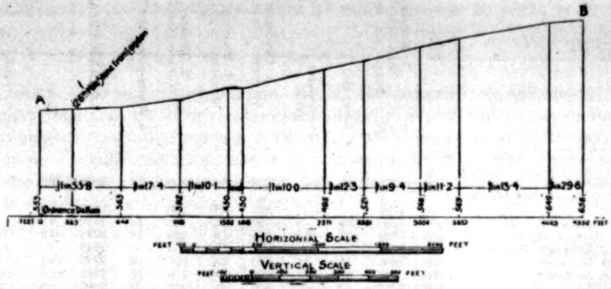
Horse-power and weight marks, Column 6, have been calculated by the following formula:—

$$\frac{\text{Horse-power as shown by performance} \times 100 \times \text{the number of passengers carried.}}{\text{Weight of car laden, less } 11\tfrac{1}{2} \text{ stone per passenger.}}$$

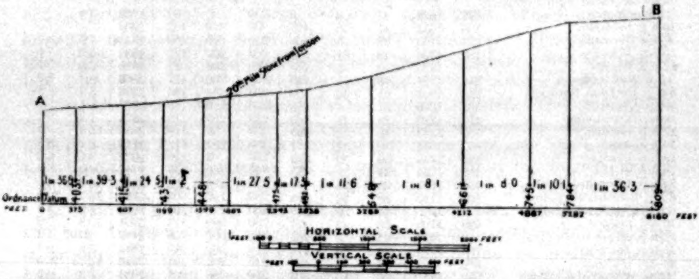
Italics mean gold medal. * Means silver medal. † Certificate for special piston rings.

Rule 29 referred to in Column 1 reads :—There will be a maximum number of marks for reliability for each day's run, viz., 800, and one mark will be deducted for every minute during which the vehicle is at rest from the time of starting to the conclusion of the run, except for three compulsory stops per day for refreshments, and stops for traffic, tyre trouble, accidental detours, and lighting carriage lamps. Rule 32 referred to in Column 2 reads :—The marks awarded for the Hill Trials will be calculated as follows :— H.P. × 100,000 ÷ price in £ × 8 for every shillingsworth of fuel consumed.

RIVER HILL - Columns 2 and 8



WESTERHAM - BETSOMS HILL Columns 2 and 9



H.P = horse-power as shown by performance, which for the purpose of this formula will be roughly calculated as follows :—Vertical height of hill in feet × weight of car and load in lbs. for every ton of total weight + 40 lbs. ÷ time in minutes/33,000. Appended are the profiles of River Hill and Westerham Betsoms Hill. M. O'G.

2139. *Stability of Automobiles on Curves.* **A. Petot.** (Comptes Rendus, 134. pp. 765–768, April 7, 1902.)—The paper contains a simple mathematical consideration, with a view to the guidance of experimental work, of side-slip and the tendency to upset when an automobile is turning, or following a curved route. When travelling in a circle there will be more tendency to side-slip on the part of the front wheels with increasing speed, and on the part of the rear wheels with diminishing speed. To prevent the latter effect when braking, the brake must therefore be gradually applied. When the radius of the circle is decreasing—in other words, when the curvature of the path is increasing—the tendency of the front wheels to side-slip is accentuated, and that of the rear wheels when the curvature decreases, as, for example, in passing from a curve to the straight. The formulæ show clearly that, in order to avoid side-slip, the transition from one curve to another of different curvature must never be made abruptly, and the author believes that attempting to do this has been the true cause of several serious accidents which have been attributed to defects in the steering gear. A point which should be noted by designers and builders of motor cars is that the tendency to side-slip can be reduced by so distributing the weight of the car and its contents as to make the swing radius about the vertical through the centre of gravity as small as possible [that is by a concentration of the weight as near as possible to this line], and it is also of advantage that the weight should be symmetrically disposed with regard to it. G. W. de T.

2140. *Renault Racing Cars.* **L. Fournier.** (Locomotion Automobile, 9. pp. 406–409, June 26, 1902.)—Describes the Renault voiturette of the "Circuit du Nord à l'alcol" type which is fitted with a 9-h.p. single-cylinder de Dion engine. The general arrangement of the mechanism is essentially similar to that of earlier types. [See Abstract No. 957 (1902).]

C. R. D'E.

2141. "*Rex*" *Motor Bicycle and Cars.* (Automotor Journal, 7. pp. 267–268, June 28, 1902.)—The Rex bicycle is a compact and strongly built machine carrying a 2-h.p. vertical engine mounted between the sides of the bottom bracket which is a malleable casting of special design. The engine has cylinder body and head cast in one piece and cooled by deep radiating ribs of square outline. The transmission to the rear wheel is by a V-section belt. Above the engine is mounted the surface carburettor and petrol tank, which contains a supply sufficient for 100 miles. The lubrication of the engine is effected by a hand pump.

The "Rex" cars are constructed in three sizes fitted with single-cylinder, vertical engines of from 6·5 to 9 h.p., and a larger vehicle of 12 h.p. has a double-cylinder engine. These engines are all water-cooled, with cylinders, bodies, and heads cast in one piece, and fitted with throttle governors. The smaller vehicles have change gears giving three speeds forward and one reverse, while the 12-h.p. car has four forward speeds. The former is transmitted through a friction clutch to the change gear and by bevel gearing to the live rear axle. C. R. D'E.

2142. *de Dietrich Lorry.* (Locomotion Automobile, 9. pp. 358–359, June 5, 1902.)—The latest type of internal combustion engine propelled lorry produced by this firm is described. It has a double cylinder horizontal engine mounted towards the front of a rectangular steel underframe and a transmission gear comprising a long belt from an extension of the crank-shaft to the first motion-shaft of the change-speed gear, and independent chains from the extremities of the second motion-shaft to the rear road wheels. The change gear gives four speeds forward and one reverse by means of sliding spur wheels. The engine may be run on either petrol or alcohol fuel. A cab enclosing the driver's seat occupies the front end of the underframe, and behind this is the body of the waggon. C. R. D'E.

2143. *Meredith Petrol Car.* (Automotor Journal, 7. pp. 224–225, June 14, 1902.)—In this vehicle the engine is horizontal and mounted towards the front of the underframe. It has two cylinders, 4·5 in. bore × 5 in. stroke mounted nearly opposite one another and bolted to the crank-enclosing chamber. The cylinders are water-cooled and 10 b.h.p. is developed at 700 r.p.m. The crank-shaft lies transversely to the underframe, and at its inner end outside the crank chamber is mounted the flywheel and friction clutch, from which the power is delivered to the first motion-shaft of the change-speed gear, this shaft being in line with the crank-shaft. Four sliding bevel wheels are mounted on the first motion-shaft, and these may be engaged with three bevel wheel rings on a disc keyed to a longitudinal shaft, from which the power is delivered to the live rear axle. The bevel change gear gives three speeds forward and one reverse. C. R. D'E.

2144. *Cronan Light Petrol Car.* (France Automobile, 7. p. 381, June 14, 1902.)—This car is fitted with a double-cylinder, horizontal engine, and a change-speed gear giving five changes forward and one reverse by wheels always in mesh; the final transmission is by bevel gearing to the live rear axle. A special feature is the timing gear for the electric ignition which is automatically advanced or retarded according to the speed of the engine. The throttle valve regulating the power of the engine is controlled by a rotational movement of the change-gear operating lever which is mounted on the steering pillar. C. R. D'E.

2145. *Chauveau Petrol Carriage.* (France Automobile, 7. pp. 394–395, June 21, 1902.)—The paper describes a type of car vehicle in which the power is transmitted to either of the rear road wheels independently, the one wheel having a higher ratio of gearing relative to the engine than the other. In this manner two changes of speed may be obtained and the differential gear suppressed. C. R. D'E.

2146. *Humber Petrol Cars.* (Automotor Journal, 7. pp. 213–218, June 14, and pp. 242–246, June 21, 1902.)—This is a detailed illustrated description of these vehicles. They are fitted with either a two-cylinder 8-h.p., or four-cylinder 12-h.p. engine, the general features of both types being almost identical. The underframe is constructed of steel tubing, and is sprung on semi-elliptic plate springs from front and back axles. The engine is mounted towards the front of the frame and covered by a bonnet. The power is transmitted through a cone friction clutch to the change-speed gear, which is of the sliding spur wheel type, and thence by a jointed tail-shaft and bevel gearing to the live rear axle. In the 12-h.p. engine the cylinders are of 3·5 in. bore and 4 in. stroke, and the normal speed is 900 r.p.m. The cylinders are water-cooled and fitted with both tube and electric ignition. Governing is effected by preventing the lifting of the exhaust valves. The carburettor is of the float-feed spraying type. In the friction clutch between engine and change gear a special feature is the placing of the springs so as to avoid end thrust. To allow for flexure in the frame a coupling is introduced between the clutch and the first motion-shaft of the change gear. The steering is controlled by a hand wheel, and three levers are provided for change speed, reverse, and driving-wheel brakes respectively. The clutch and a counter-shaft brake are operated by pedals. C. R. D'E.

2147. *Bertrand Petrol Car.* (France Automobile, 7. pp. 359–362, June 7, 1902.)—This is a simple, light, petrol car in which the engine is mounted towards the front of the underframe with crank-shaft placed transversely and a long belt employed to transmit the power to a two-speed change gear mounted behind and carried from the live rear axle. When not driving, the belt runs on a loose pulley between two fixed pulleys, which correspond to two ratios of spur gearing between a counter-shaft and the axle. The reverse is obtained by a sun and planet motion within the loose belt pulley, this gear being brought into action by means of a pedal-controlled band brake which holds the planet pinions. C. R. D'E.

2148. *Wolseley Petrol Cars.* (Automotor Journal, 7. pp. 192–194, June 7, 1902.)—Describes some further details of the transmission and steering gear on these vehicles. The countershaft and rear road wheel brakes are also illustrated and described. [See also Abstract No. 1782 (1902).] C. R. D'E.

2149. *Martin Pneumatic Tyre.* (Automotor Journal, 7. pp. 268–269, June 28, 1902.)—This is a single-tube pneumatic tyre, but with accessible interior. In section the tyre is like an ordinary pneumatic, but with sides turned down and without beading. The extended walls butt up against the faces of the wood felloe of the road wheel, and are clamped thereto between metal side discs. By detaching one of these metal rings the interior of the tyre is readily accessible. C. R. D'E.

REFERENCES.

2150. *Vertical Compound Engine.* (Engineer, 93. pp. 456–458, May 9, 1902.)—This is a description of a 1,000-b.h.p. engine for the electric supply of Cape Town, built by Ferranti's, of Manchester. [See also Abstract No. 148 (1902).] H. R. C.

2151. *Determination of Stresses in the Upright Pillars of Vertical Steam Engines.* **G. Schwarz.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 724–729, May 17, 1902.)—The paper contains a mathematical and graphical treatment of frame stresses arising from the bending moments set up by the forces producing rotation. An elementary case is first considered and then developed. Engines of the Willans type whose pistons are only subject to a unidirectional pressure are included in the paper. R. C. R.

2152. *Metallic Packings.* **C. G. Robbins.** (Power, N.Y. 22. pp. 15–24, April, 1902.)—Descriptions are given of the principal packings now in use in the United States. G. W. DE T.

2153. *Steam-Engine Packing.* **A. McSwiney.** (Mech. Eng. 9. pp. 739–744, May 31, 1902. Abstract of paper read before the Birmingham Association of Mechanical Engineers.)—A description is given of various forms of metallic packings and stuffing-boxes. H. R. C.

2154. *Bunsen Air Injector Burners.* **J. S. V. Bickford.** (Horseless Age, 9. pp. 635–637, May 28, 1902.)—In this article the author describes a number of experiments he has made and the apparatus used in them. C. C.

2155. *Progress in Aëronautics.* **G. Espitallier.** (Génie Civil, 40. pp. 289–294, March 1; 309–313, March 8; and pp. 229–333, March 15, 1902.)—The first of these papers deals with the Santos-Dumont balloon (see Abstract No. 2457 (1901)], while in the second the author discusses the physical problems of the equilibrium of an elongated balloon, the dynamics of its motion through the air, the determination of the requisite motive power, and direct and indirect methods of measuring the velocity. G. W. DE T.

GENERAL ELECTRICAL ENGINEERING.

2156. *Accumulator Tests.* **M. U. Schoop.** (Centralblatt Accumulatoren, 3. pp. 93–96, April 15, and pp. 109–111, May 1, 1902.)—The researches described in these articles are in continuation of the author's investigations into the nature of the changes of discharge e.m.f. and p.d. [See Abstract No. 1348 (1900).] A number of curves are given showing the variations under different conditions of treatment, and from these it is deduced that their character is determined by (*a*) the rate of the previous recharge; (*b*) the length of time that elapses between the recharge and discharge; (*c*) the strength and temperature of the electrolyte; (*d*) the rate of discharge. Another series of curves shows the effects, upon positive and negative separately, of altering the thickness of the electrodes; and the diffusion phenomena from which they arise are discussed at considerable length.

E. J. W.

2157. *Influence of Temperature on Capacity of Accumulators.* **W. Hibbert.** (Elect. Rev. 50. pp. 883–884, May 30, 1902.)—The author discusses the results obtained by Dr. Gladstone and himself in 1892, and also more recent experiments of Schoop, Heim, and Liagre. [See Abstracts Nos. 2251 and 2465 (1901), and 393 (1902).] Heim finds the increase in capacity to equal 3 per cent. for each rise of 1° C., and Leagre shows that the percentage increase depends on the discharge rate. Heim gives the following figures for five large cells, working at a three-hours' rate—

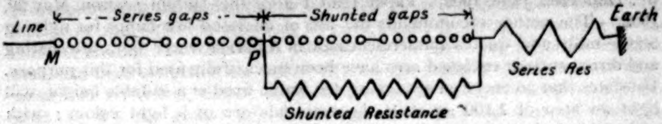
		Ampere-hours.		
Temp.	Amperes.	Charge.	Discharge.	Efficiency.
12°	140	437	386	0·88
44·9	140	896	735	0·82

showing an increased capacity of 100 per cent.

All the results obtained may be explained as due to the increased diffusion of the acid in the pores of the active material. At low temperatures, the diffusion rate is too small to keep up the strength of the acid when from ½ to ⅓ of the active material has been changed to sulphate; at higher temperatures, the increased rate of diffusion keeps up the strength of the acid in the pores until much more sulphate has been formed. Heim recommends that accumulator rooms should be warmed in order to increase the capacity; the author dissents from this, owing to the increased local action on the positive plate, and the direct sulphating of the negative at the higher temperatures. Dr. Gladstone and the author pointed out this disadvantage in 1892, but also showed that the increased local action on both plates might be counteracted by a reduction in strength of the acid (Journ. Inst. Elect. Engrs., 1892, p. 31).

W. C. B.

2158. *Use of Shunt and Series Resistances in Lightning Arresters.* **P. H. Thomas.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 663–676, May, 1902.)—The "multi-gap" lightning arrester for alternating-current circuits consists of a number of small air-gaps, the terminal of the last air-gap being connected to earth through a resistance. Such a series resistance is found necessary for the purpose of preventing the large rush of current which would otherwise follow discharges, causing a dimming of the lamps and throwing synchronous apparatus out of step. The use of such a series resistance of relatively high value in the path of the discharge is evidently in general an objectionable feature in the arrester. The value of the resistance may be reduced by the use of another resistance, which is arranged as a *shunt* across a number of the air-gaps. The arrangement is shown in the accompanying sketch. It is evident that when the arrester is not in action, the point P is at the potential of the earth; hence the voltage on the line necessary to cause the arrester to discharge is that required to break down the series gaps alone. When this happens the points M and P are momentarily reduced to practically the same potential, and the impulsive rise of potential at P next breaks down the shunted gaps. A current from the generator then follows the discharge, establishing arcs between the gaps. If, however, the arrangement is properly designed, the shunt resistance will take the bulk of the current flowing from P to earth, and the arcs in the shunted gaps will die out. The current now has to pass through the two resistances in series, and this reduces it so much that the arcs across the series gaps are entirely suppressed. The author discusses in detail the various points to be considered in designing an arrester of this type, and gives an account of the experimental investigations which he has carried out on this subject. A. H.



2159. *Construction of High-Tension Central Station Switchgears.* **H. W. Clothier.** (Inst. Elect. Engin., Journ. 31. pp. 1247–1264; Discussion, pp. 1264–1272, June, 1902.)—The paper deals with the construction of station switchgears as applied to the control of alternating currents. Various types of gear are described, being sectionised under two headings (*a*) gears with backs; (*b*) gears without backs; these being subdivided into boards of the (1) flat, multi-frame, cubicle, basement, and keyboard types; (2) wall surface, hinged panel, pillar, and cellular types. The advantages of the different types are entered into, and the trend of the paper leads up to the most modern examples of switch-gears as recently installed in this and other countries. The author then compares the designs of British and German gears, drawing attention to the amount of space occupied by the latter, this being almost three times that taken up by the former. The bus-bar arrangements are fully discussed, and every feasible method of operation is described, attention being drawn to the departure from the simplicity of the older boards in the designs adopted for polyphase working. When arrangements were made for the supply of traction and lighting circuits from one station, it was possible that separate high-tension bus-bars were not required, in which case considerable economy would be effected, not only in the first cost of the gear, but also in the running of the station. Switches of the oil-break type are considered to be superior to those breaking in air, in that with the former the arc is suitably extinguished and rises of potential are kept down, whereas oscillations, likely to produce serious results, are set up when flare-switches are employed. If there were many underground cables on the system, it became necessary to adopt feeder-charging gear to gradually raise or lower the pressure on any cable. The simplest and best method of connecting wattmeters in circuit was to place them between the generator and feeder panels, where they would register the entire output of the plant. The paper concludes with the expression of a belief that the tendency towards standardisation would produce a much simpler type and arrangement of gear than the designs at present in vogue. W. E. W.

2160. *The Lighting and Driving o, Textile Mills by Electricity.* **M. Osborne.** (Inst. Elect. Engin., Journ. 31. pp. 1273–1280; Discussion, pp. 1280–1282, June, 1902. Paper read before the Dublin section, May 29, 1902.)—The author recommends the use of enclosed arc lamps for lighting textile mills, and quotes numerous cases in America where both alternating and direct current enclosed arcs have been successfully used for this purpose. He states that an enclosed arc taking 480 watts, fixed at a suitable height, will light an area of 1,100 sq. ft., if the materials are of a light colour; with materials of dark shades the area is reduced to 600 sq. ft. Incandescent lamps absorbing the same power would only illuminate half the same areas. The discussion, however, showed some divergence of opinion on this point. Some speakers considered that arc lamps were essentially unsuitable for textile operations, and very different estimates were given as to the precise amount of light required. As for the question of electrical driving, the author gave a general description of a large number of cotton mills abroad which were so driven, but instances were not to be found in England. In the case of a new mill, the author considers that it is evidently an advantage to adopt electrical machinery, and quotes the case of a mill of about 100,000 spindles, for which two sets of plans and estimates were prepared. One embodied electrical transmission of power, and the other was to be mechanically driven. The estimates for the electrical scheme were found to be the cheaper, in that it was possible to reduce the cost of the building by 10 per cent., the cost of shafting by 61 per cent., and the cost of belting and ropes by 66 per cent. This saving more than compensated for the cost of the electrical plant.

W. H. S.

REFERENCES.

2161. **P. Bayol.** (Écl. Électr. 30. pp. 265–275, Feb. 22; and pp. 342–348, March 8, 1902.)—A mathematical study of geometrical and other problems presented in the design of submarine cables. M. O'G.

2162. *Central Station Resistance Coils.* **P. Gesing.** (Elektrotechn. Zeitschr. 23. pp. 293–294, April 3, 1902.)—The author considers the usual calculations necessary for the construction and dimensioning of resistance regulators, as used in central stations, much too complicated, and gives a special table, from which, knowing the voltage of the dynamo, which is considered a constant, the lamp voltage, the maximum and minimum current, and the degree of adjustment required, the required dimensions can be obtained approximately from this without much calculation. L. G.

2163. *Automatic Transformer Switches.* **Winkler.** (Zeitschr. Elektrotechn., Wien, 20. pp. 221–223, May 4, 1902.)—A discussion of the points required of an automatic transformer switch, with a brief review of the attempts which have hitherto been made to fulfil the requirements. The author concludes that no completely satisfactory apparatus of the kind has yet been produced. A. E. L.

GENERATORS, MOTORS, AND TRANSFORMERS.

2164. *Regulation of a Gas-Engine Dynamo.* **Lauriol.** (Soc. Int. Élect., Bull. 2. pp. 418–424, June, 1902.)—The plant experimented on consisted of two dynamos driven by the same gas engine which was governed on the reduced charge system. Each dynamo supplied current at 1,500 volts for a constant load of arcs, the one a Henriot series machine giving a much steadier supply than the other, a Gramme machine separately excited. Girard proposed rectifying the unsteadiness produced by cyclic speed variations in the circuit of the Gramme machine, by periodically inserting resistance in the exciting circuit. The first trials showed that the necessary variation in resistance had been estimated too low. After some trials, a satisfactory arrangement was arrived at, the variation in the supply being reduced from 10 per cent. to 3·5 per cent. The theoretical difficulties encountered and the influence of self-induction are discussed. The latter necessitated a lead in the motion operating the resistance. The method is not applicable to hit-and-miss governed engines and no mention is made of variable load. Hospitaliers' ondograph method was employed for measuring the variation in the current supplied to the arcs. R. C. R.

2165. *Commutator Design.* **A. Rothert.** (Elektrotechn. Zeitschr. 23. pp. 309–314, April 10, 1902.)—This paper contains a critical review of the various theories of commutation, with special reference to Parshall and Hobart's method of calculating the "reactance voltage" of a short-circuited coil, and the effect of mutual inductance in cases where several coils are simultaneously short-circuited by the brush. Following Parshall and Hobart's method, the author developes the following formula for the reactance voltage :—

$$\text{Reactance voltage} = \text{constant} \times \frac{(\text{no. of conductors})^2 . (\text{length of iron} + 0{\cdot}1 \text{ free length}) . (\text{current in each conductor}) . (\text{revs. per min.})}{\text{number of commutator segments}}$$

The "free length" in the above formula stands for the length of conductor outside the slot. The value of the constant may be taken as 208×10^{-9}, the lengths being assumed to be expressed in cms. This formula enables us to find the number of segments for a given assumed value of the reactance voltage. A. H.

2166. *Alternator with Commutator.* **M. Latour.** (Soc. Int. Élect., Bull. 2. pp. 383–401, May, 1902.)—The author gives a description of his self-exciting polyphase alternator [see Abstract No. 1235 (1902)], pointing out its relation to continuous-current machines on the one hand, and ordinary alternators on the other. He refers to Heyland's work [see Abstract No. 2475 (1901)] and states that his own construction is practically identical with Heyland's, and that the only difference between them consists in the use of short-circuiting resistances between the commutator segments by Heyland—an arrangement whose sole object is to suppress sparking when only a small number of commutator segments is employed. The author criticises this arrangement somewhat severely, and regards it as quite unnecessary. A. H.

2167. *New Method of Compounding Generators.* **F. G. Baum.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 511–523, May, 1902.)—As applied to an alternator, the author's method of compounding is shown diagrammatically in Fig. 1, where G is the generator, the main current from which excites the poles PP′ of the "compensator." This latter consists of a field magnet between whose poles is rotated a single coil of wire, one end of which is attached to a continuous ring, while the other is connected to two segments (each extending over 90°) of a split ring, these segments being in metallic connection with each other. The e.m.f. developed by the armature of the compensator is injected into the field circuit of the exciter. The compensator is driven synchronously with the generator by suitable gearing. The e.m.f. developed by it consists of a portion of an alternating wave of e.m.f., and may itself be either alternating or uni-directional, depending on the phase of the current relatively to the position of the compensator armature. The phase of the current thus determines the amount of e.m.f. injected into the field circuit of the exciter. In practice, instead of connecting the exciter field and the compensator armature in series, the latter is allowed to excite the field of a small dynamo whose armature supplies current to a

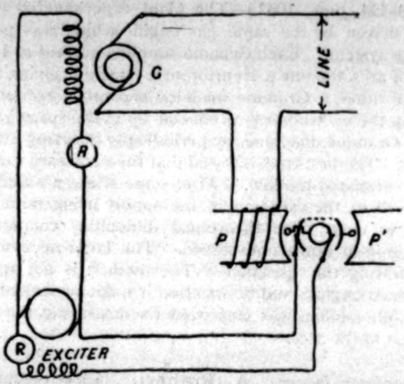


FIG. 1.

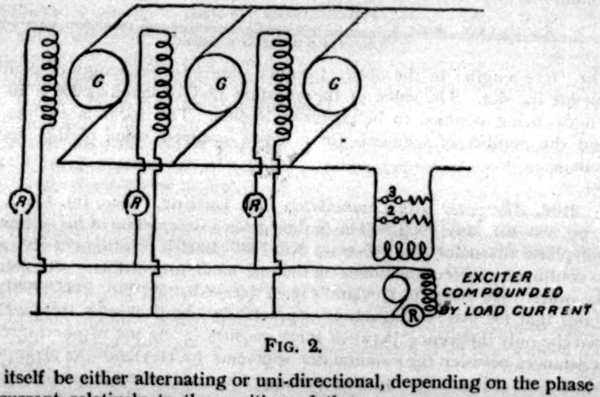


FIG. 2.

special series coil on the exciter. A method of compounding continuous-current generators analogous to the one just described for alternators is shown in Fig. 2, where the G's represent the generator armatures, the R's rheostats in their field circuits, and 2 and 3 are shunts across the exciter series coil, by means of which the compounding may be varied to suit the number of generators running. The author states that these methods have given very good results in practice. A. H.

2168. *Determination of Alternator Characteristics.* **L. A. Herdt.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 723–751, May, 1902.)—The relations between the values of the e.m.f. current and induction fluxes of alternators under varying conditions of load and power-factor are discussed theoretically, and the conclusions arrived at are tested by careful and elaborate experiments on various types of machine. The reluctance of the path of the armature flux of an alternator is periodically changing, and it is shown that this fluctuation has a marked effect on its regulation and wave-form. E.m.f. current and induction waves are drawn for an inductor alternator on non-inductive, inductive, and condenser loads respectively. The great change in the shape of the wave which occurs in this type of machine is a drawback in practical work. The shape of the induction wave with quadrature current proves that the diminution of voltage on an inductive load is almost entirely due to the demagnetising effect of the armature current. Several indirect methods of determining alternator regulation are given. The method of predetermining the regulation from the short-circuit characteristic is shown to be inaccurate owing to the demagnetising effect of the quadrature current being much greater when the field excitation is weak and also because the power and inductance factors of the load are not the same as the power and inductance factors of the whole circuit. Blondel's "two reaction" method is given, and it is stated that it neglects armature self-induction. The author gives a new method which he calls the "two reactance" method. The armature, instead of being short-circuited, is operated at full load field excitation on a suitable variable reactance and the difference between the terminal voltage and the no load voltage is noted. This voltage drop divided by the current gives the value of the demagnetising component of the "synchronous reactance" or the combined effect of armature reactance and the stray field due to the cross magnetising effect of the armature current. The cross magnetising effect is equal to this demagnetising component multiplied by the ratio of the maximum to the minimum value of the armature reactance. It is shown that the various values of the armature reactance can easily be found by passing an alternating current of known frequency through the armature held fixed in various positions. The characteristics for various power-factors determined in this manner agree with the actual curves within the limits of experimental error. A. R.

2169. *Multiple-Speed Motor.* (Power, N.Y. 22. pp. 45–46, June, 1902.)—No rheostats of any description are used in this motor, which is manufactured by the Stow Manufacturing Company, of Binghamton, N.Y., the speed variation being obtained by varying the reluctance of the magnetic circuit. The machine illustrated is a 6-h.p. motor capable of running sparklessly at from 700 to 1,500 r.p.m. From a circular yoke project 4 pole-pieces of special construction, each consisting of an outer hollow cylindrical casing whose inner end is shaped to form the pole-shoe, and a solid piston capable of sliding inside the hollow casing. The outer end of the piston is provided with a screwed shank which passes through a nut, the nut forming the boss of a bevel wheel. By means of a single hand-wheel and a suitable arrangement of bevel gearing the four pistons may be moved simultaneously through equal distances in a radial direction. An outward displacement of the pistons increases the reluctance of the magnetic circuit by increasing the length of air column between the inner end of the piston and the armature core. Sparkless running is said to be obtained by the great increase in the induction close to the polar tips. A. H.

2170. *Theory of Synchronous Motor.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 547–567, May, 1902.)—After briefly sketching the theory of the synchronous motor, the author draws a series of curves connecting output with current, power-factor and efficiency, for a given excitation. These curves closely resemble similar curves for the induction motor, but while an induction motor has only one series of load curves a synchronous motor has an infinite number of them, each value of the exciting current corresponding to a different set of load curves. The load curves for one particular value of the exciting current show that the power-factor is practically unity over the whole range of load up to near the maximum output. The author next considers sudden changes of load and their effect in setting up surging or hunting; a formula is deduced for the frequency of the oscillations when these are small, and its application to a numerical example brings out the fact that the frequency of oscillation does not vary much with the load and the excitation; it slightly decreases with increase of load, and increases with increase of excitation. The concluding section of the paper deals with the effect of changes in the load due to changes of speed, and with anti-surging devices. A. H.

2171. *An 80,000-Volt Transformer.* (Elect. World and Engineer, 39. pp. 1067–1068, June 14, 1902.)—A 330-kw. transformer of this voltage is described, recently built by the General Electric Co. for the local lighting and power company in Butte, Mont., the distance of transmission being 60 miles. It is of the oil-insulated type, similar in design to the 500-kw. 60,000-volt transformers recently made by the same company. The method adopted for forcing the oil into the interstices of the windings is to exhaust all air with a vacuum pump (the transformer case and all joints, glands, &c., being made airtight for this purpose), heat the windings to expel all moisture, and then to allow the oil to flow in under atmospheric pressure. The spaces between the high voltage coil and the other parts are subdivided into separate ducts by diaphragms of solid insulation, so that any conducting particle which might chance to fall into the oil should do the least possible harm. The transformer was designed more with a view to absolute reliability than for high efficiency, which is given as 97·5 per cent. at 60 cycles. The regulation is stated to be 1 per cent., reactance 4 per cent., heating (by resistance) 30° C. Insulation tests made at 160,000 volts failed to develope any weakness; but during these tests it was found necessary to fix india-rubber discs on the terminal cables, as otherwise an arc formed between the ends of the cables and the transformer tank, even over a distance of 5 or 6 ft.; the discs broke the continuity of the static discharge and prevented arcing. At the normal pressure of 80,000 volts there is no brush discharge whatever, and the discs are therefore not necessary in ordinary operation. Tests were made for dielectric hysteresis, but no losses due to this cause were observed. B. P. S.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2172. *Earthing High Potential Systems.* **J. D. Nies.** (Elect. World and Engineer, 39. pp. 639–642, April 12, 1902.)—The author discusses mathematically the part played by static capacity when the zero point is earthed in monophase and polyphase systems. If the static capacity between the lines and earth was negligible, earthing would obviously introduce a source of danger. This, however, is very rarely the case, and in most cases occurring in practice this static capacity is a source of danger as great as, or greater than, that due to earthing. In such cases, earthing will usually not sensibly increase the danger arising from accidental contact with the lines, and will frequently diminish it to a considerable extent. As earthing, in most cases, conduces to reliability of operation, the conclusion is that it is usually advisable. G. W. de T.

2173. *Steel Posts.* (Electricien, 23. pp. 326–328, May 24, 1902.)—These are made by Genissien, 32, rue de Greffselhe Levallois Perret (Seine), by bolting together two channel irons so as to give the appearance of a square post. Taper is obtained by sliding smaller irons within the larger ones and covering the join with a cast-iron moulding. The post is 80 per cent. cheaper than tubular posts, and 30 per cent. cheaper than trellis-work. It may be installed by a pile driver, is easily ornamented, and from its square shape and the slot between the two channels it is adapted to support an arm without even being drilled with holes. M. O'G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2174. *The Joliet Water-power Plant.* (Eng. Record, 45. pp. 362–365, April 19, 1902.)—This plant, deriving power from the Chicago drainage canal, presents some interesting features on account of the low head utilised, and the large amount of water available. The plant will have ultimately a capacity of 7,000 h.p. at the switchboard. The high-water head is 9 ft., and the head at all stages between high and low water somewhere between 9 and 14 ft. The low-water flow contemplated is 420,000 cubic ft. per minute under 14 ft. head. To give the same power under 9 ft. head will require 653,000 cubic ft. of water per minute. The high-water flow, it is calculated, amounts to 1,500,000 cubic ft. of water per minute. The highest efficiency of the wheels was desirable at low water and high head. The power-house is 45 ft. wide and 875 ft. long. The ultimate installation of 40 turbines is provided for. A flow into the Illinois and Michigan canal of 30,000 cubic ft. of water, at a fall of 14 ft., drives one 375-kw. generator, from two 66-in. "New Success" turbines. The bay for each turbine of this pair is arranged to discharge the water either into the basin at the mouth of the tunnel or into the tailrace carrying the water from the rest of the wheels. The head under which the wheels operate is substantially constant. Two 750-kw. units, each driven by three 66-in. McCormick turbines, have been installed. There are also two 75-kw. 125-volt exciters with their wheels, each having sufficient capacity for the whole plant. The masonry and the floors of the building are of concrete. The superstructure is of hollow tile walls and steel framework. When the head falls as low as 9 ft., six 66-in. wheels are needed to drive one 750-kw. generator. Each unit therefore has six wheels, three of which can, by means of clutch couplings, be coupled to the generator at will. The auxiliary turbines are "New Success" turbines of the wicket-gate type. The exciter of the 375-kw. generator is driven by a 48-in. wheel. The turbines are of the vertical type, and are connected by means of bevel gearing to the horizontal shaft, to which the alternator shaft is coupled. The cone wheels have but 3·5 in. pitch, and have run satisfactorily. The scheme of regulation is believed to be entirely new. Lombard governors are used, and act on the cylinder gates only. The arrangement gives a rigid connection between governor and gates, and works well. When loaded to 600 kw., the instantaneous removal of 400 kw. caused a change of only 2 cycles in 60, with recovery in a second or two. The turbines are located at the bottom of the chamber, which is 9 ft. below the level of the top of the dam. The turbine floor level is normally 1 ft. above the tail at low level. The tailrace is 75 ft. wide. The alternators are of the revolving field type, containing 36 poles. They run at 200 r.p.m., and give three-phase current at 60 ∿ and 2,300 volts. For transmission purposes for street railway service the step-up transformers give 15,000 or 25,000 volts, according as the connections are made in the delta or star fashion. There are four transformers of 200 kw. each, air-cooled by centrifugal fans. The high-tension lines are controlled by double-throw oil-break switches. L. G.

2175. *The New Shoreditch Electricity Works.* (Elect. Engin. 29. pp. 870–877, June 20, 1902.)—*System.*—High-pressure continuous current, generated at about 1,100 volts; distribution to consumer on two-wire system. The boiler-room contains four water-tube boilers of the Babcock and Wilcox marine type, each having a heating surface of 2,720 sq. ft. The grate area of three is 73¼ sq. ft., the fourth 68 sq. ft. The four boilers combined produce about 50,000 lbs. of steam per hour. The feed-water is heated by economisers, each containing 350 sq. ft. of heating surface, fitted to each boiler. Coal is stored in overhead coal store of 750 tons capacity, while an automatic railway is provided for handling and trimming, and is fired by three boilers hand fed, the fourth fitted with a double 4-ft. Babcock and Wilcox chain stoker. The engine-room contains two vertical slow-speed Corliss compound engines, running at 90 r.p.m., and capable of developing from 1,300 i.h.p. to 1,400 i.h.p. Diameter of high-pressure cylinder, 24½ in.; of the low pressure, 58 in.; stroke, 42 in. Each engine provided with a surface condenser having a cooling surface of 2,700 sq. ft. Each engine drives direct-coupled multipolar dynamo of the Westinghouse type, the rated load of each being 780 amperes and 1,100 volts. They are designed to carry an overload of 50 per cent. for two hours. The average price obtained for the year 1900–1 was 3·08d. per unit for lighting. C. E. A.

2176. *Camps Bay, Cape Town, and Sea Point Tramways.* (Tram. Rly. World, 11. pp. 134–142, March, 1902.)—The main route is about 7 miles long, with two short branches. It is extremely tortuous and very heavily graded, the average grade over one length of 1¼ miles being slightly steeper than 1 in 12, with grades of 1 in 9 for short distances. In addition to the new roadway which had to be constructed, more than 75 per cent. of the existing roads had to be widened and graded, involving much earthwork and blasting. Girder rails weighing 90 lbs. per yard, laid in strips of concrete 6 in. deep and

18 in. wide, are used for the track. The gauge is 4 ft. 8½ in., to correspond with that of the Cape Town tramways. Karri wood paving has been laid for a width of 1 ft. 10 in. on each side of the track, with a 9-in. toothing course along the inner side of each rail. Neptune rail bonds are used, and 8 ft. 8 in. cast-steel points, and 1 in 9 crossings. The overhead trolley system is employed, the trolley line being supported on side-poles of mild steel. The generating station at Camps Bay, about the centre of the system, contains two direct-coupled 400-kw. units with cross compound, 720-b.h.p. engines fitted with Corliss automatic valve gear, running at 90 r.p.m, with a steam pressure of 150 lbs. There are two Admiralty type surface condensers adapted for use with sea-water, and with combined air and circulating pumps. There are two Babcock and Wilcox boilers, each capable of evaporating 12,000 lbs. of water per hour under normal conditions. The feed-water is heated by a Green's economiser. The car bodies are mounted on bogie-type trucks, with a 4-pole-type 25-b.h.p. motor on each axle, 100 b.h.p. per car (carrying 54 or 65 passengers) being considered necessary on account of the heavy grades. Each car is fitted with three brakes: a hand brake with a brake-block on each of the eight bogie wheels, an air brake acting in conjunction with the hand-brake, and an auxiliary slipper brake. In addition to these, it is also possible, by throwing over the reversing switch, to convert the motors into generators, thus enabling them to act as a powerful emergency brake. G. W. DE T.

2177. *The Paris-Arpajon Railway.* **G. Bőeto.** (Génie Civil, 40. pp. 421–428, April 26, 1902.)—This light railway, 32 km. long, has hitherto been worked on a mixed system by steam and compressed air. These are now supplemented by an electrical system, which is worked by accumulators carried on locomotives between the Odéon and the boundary of Paris, and from this point to Antony, a distance of about 8 km., by the trolley method. Steam is also still used over the whole line, and compressed air for some of the trains inside Paris. The electric power-house is in the station which is used for generating the compressed air, and contains two 225-kw. dynamos coupled to Corliss engines, giving their output at 550 volts, and 120 r.p.m. An accumulator substation is placed at Bagneux, 3 km. from the power-house; this contains 270 Tudor cells, giving about 100 kw. for three hours. The locomotives carrying accumulators weigh 17 tons; the cells have a capacity of 110 ampere-hours, and are 250 in number. They take on an average fifteen minutes to charge. The article contains a large plate with drawings of the power-house. W. H. S.

2178. *Brockton and Plymouth Street Railway.* (Street Rly. Journ. 19. pp. 243–250, April, 1902.)—Three-phase transmission is employed, at 13,000 volts and 25 ∿, to a 13 mile distant substation. The track is laid with 60-lb. T-rails (a girder rail is used in Plymouth), and chestnut and oak ties with gravel or sand ballast, and paving on steep grades. There are four horizontal return tubular boilers, each rated at 125 h.p., with heads and shell plates of open hearth steel. The steam pressure is 125 lbs. High-pressure steam pipes are of lap-welded charcoal iron, work of 2½ in. and over being flanged. The high-pressure steam and water pipes have adjustable supports on roller bearings at least every 6 feet, the low-pressure piping having fixed supports. Warren feed-pumps are used, and exhaust primary heaters. There are two Blake jet condensers of the cross-compound vertical air-pump type, which can be operated together if desired. There are at present 3 units. (1) A 300-kw. G.E. three-phase revolving-field 380-volt alternator with 28 poles, direct-connected to a 450-h.p. cross-compound condensing engine. The speed is 107 r.p.m. with a guaranteed regulation of 2 per cent. from zero to full load, and a maximum angular variation of 0·18 of 1 per cent. at 50 per cent. overload. Multiported gridiron valves give full steam-chest pressure with short travel and little wear, and are actuated by a double-eccentric motion, allowing the widest possible range for adjustment, and a cut-off up to three-quarter stroke. This is found to give exceptional capacity for handling high-speeds and changeable loads. The speed can be varied while running, to the extent of about 10 r.p.m., by means of an electromotor connected through a sprocket chain to a screw which moves a weight along the governor trip-shaft. (2) A G.E. 300-kw. 8-pole 550-volt 105-r.p.m. direct-current railway generator direct-driven by a 450-h.p. Green-Wheelock horizontal cross-compound condensing engine. (3) A G.E. 200-kw. 550-volt direct-current railway generator, direct-connected to a 250-h.p. McIntosh and Seymour engine. Six 90-kw. 380–13,000-volt oil-cooled transformers are guaranteed, with overload capacity, to supply two 200-kw. overloaded rotaries at the substation. Each car weighs 13,000 lbs., and carries four G.E.-52 motors with K-12 controllers rated at 27-h.p. on the low basis of 75° C. temperature rise. The trucks are of the double-motor swing-bolster type, with an overall axle length of 6 ft. 2⅝ in., a length of 10 ft. 2½ in., and a wheel base of 4 ft. 4 in. Inside-hung Christensen air-brakes are used, and the motor-gear ratio is 4·78. The road is operated on the telephone despatching system. G. W. DE T.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

2179. *The Zossen Marienfelde Polyphase Railway Trials.* (Engineering, 73. pp. 547–548, April 25, 1902.)—In the trials hitherto made special attention was given to the following points: (1) Starting and braking at speeds up to 100 km. (62 miles); (2) running at uniform speeds up to 100 km.; (3) propulsion at uniform speeds up to 130 km. (81 miles); (4) propulsion by high-pressure currents at speeds above 130 km. The rails on this line weigh only 34·4 kg. per m. (67·5 lbs. per yd.), and rest partly on wooden and partly on iron sleepers. As expected, the defects in the track became manifest at high speeds. Up to 100 km. no concussions were noticed in the carriages, nor were distorsions observed. After 140 km. (87 miles) there was slight rolling, owing to the lightness of the permanent way. The three-axled bogies were quite satisfactory, giving noiseless motion without any jolting at the rail joints. The experiments would tend to show that rails weighing 42 kg. per m. (84·5 lbs. per yd.) would be quite heavy enough for speeds up 160 km. (100 miles). The quiet motion was doubtless largely due to the complete balancing of the car. There was very little sparking, even at the highest speeds, at the contact bows, which exerted a pressure of 4–6 kg. (9–13 lbs.) against the trolley wires, and, when observed, it could be traced to slight defects in details. Lateral oscillations in the car were only observed at speeds below 60 miles. The heating of the transformers on the car did not exceed 35° C. At the lower speeds employed in the earlier trials, the trolley-line pressures varied from 6,000 to 8,000 volts, with a periodicity of 25–30. For the higher speeds the pressure was raised to 10,000 volts with a periodicity of 36, and temporarily to 13,500 volts with a periodicity of 48. At the highest speeds, between 99 and 100 miles an hour, the rails began to yield, both horizontally and vertically, so that the tests had to be interrupted, pending the strengthening of the permanent way. With regard to braking, the conclusions arrived at were that further and more efficient means should be devised. Braking by current reversal is not to be recommended, as it endangers the motors. The power consumption, depending on the speed and the starting acceleration, varied between 400 kw. and 700 kw. With a power consumption of 184 kw. a uniform speed of 90 km. (56 miles) could be maintained, and 140 km. (87 miles) with 520 kw.; so that about 1,100 h.p. would be required for a speed of 200 km. (125 miles). The air-resistance experiments showed that the rise in air pressure did not extend beyond a distance of 3·8 m. in front of the car. The rounding of the sides and roof was found to be a very important feature. There was practically no increase of pressure on the rear portion of the car, nor was any noteworthy suction effect observed in its wake. [See also Abstract No. 598 (1902).] G. W. DE T.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

2180. *High-Speed Electric Railways.* **G. W. Meyer.** (Zeitschr. Elektrotechn., Wien, 20. pp. 169–174, April 6, 1902.)—The author commences by discussing certain formulæ for the determination of the horse-power required to drive a train at certain speeds, taking into account the air resistance. He also refers to the work already done by Reichel, Kapp, and others on this subject. He then proceeds to consider the system most suitable for main lines, and thinks that this must obviously be the polyphase system without any admixture of direct current or rotary convertors. Two methods are therefore possible, viz., system A, in which the high-tension current is transformed in substations, placed at intervals along the line, alternate current being then supplied at lower pressure to the locomotives; and system B, in which the high-tension current is transformed by transformers carried by the trains themselves. The trains are supposed to consist of single cars, holding 90 persons; on system A, the loaded cars would weigh 110 tons, and on system B, 145 tons. The speed is taken as being 180 km. per hour with a maximum speed of 200 km. By the application of the formulæ, a train on system A is found to require 1,800 h.p., or 1,420 kw., allowing for losses in the motors; on system B, it would require 2,000 kw., allowing for losses in motors and transformers. The former therefore requires four 500-h.p. motors, and the latter four 600-h.p. A further allowance must be made in favour of system A in consequence of the fact that much higher transmission pressures are possible in this case; current transmitted at the highest pressures cannot conveniently be dealt with on the train itself, whereas a pressure of 55,000 volts presents no difficulties in substations. The author then considers the case of running half-hourly trains between New York and Chicago, and calculates that the amount of power required under the two systems would be in the proportion of 10 to 13. In consequence of the higher pressures used in system A, one or at the most two central stations should be possible; in the case of the New York and Chicago line, the whole could be supplied from Niagara, and each substation would supply 40 km. of the line at 6,000 volts. Supposing in the case of B that 20,000 volts was a possible pressure, the Chicago and New York line would require ten central stations, and each of these would supply a length of about 160 km. of the line. W. H. S.

2181. *Competition of Steam and Electric Railways.* **C. H. Davis.** (Street Rly. Journ. 19. pp. 310–314, April, 1902. Paper read before the Canadian Society of Civil Engineers.)—The paper discusses in detail, with numerous curves and tables, the financial effects of the competition of electric street railways, on various steam railroads in the United States, during the period from 1889 to 1898. The conclusion arrived at is that where steam railroads have been seriously affected by the competition it is almost invariably due to their routes being ill-adapted for local traffic, and that the general effect of the development of the electric street railways is to largely develope local passenger traffic, and, by good management on the part of the steam railways, may be made to act as feeders to them, and therefore increase, instead of diminishing their profits. G. W. DE T.

2182. *Electric Railways.* **L. Gerard.** (Soc. Belge Élect., Bull. 19. pp. 183–281, April, 1902.)—This is a critical discussion of the various systems of electric traction, with illustrations drawn from numerous important systems in use in Europe and America. The relative advantages of electricity and steam are specially discussed, the preference being given to the former, mainly on account of the high efficiency attainable and the reduction of dead weight to a minimum. Accumulator attraction is at a disadvantage in both these points, and is only to be contemplated under quite special conditions. G. W. DE T.

2183. *The Diatto Surface-Contact System.* **C. H. Julius.** (Assoc. Ing. Él. Liège, Bull. 2. pp. 63–126, Jan., 1902.)—This is a very complete treatise on the system, with a discussion of its development and working in Paris, a comparison of its capital and maintenance costs with those of the trolley system, and a full consideration of the various imperfections which have been disdiscovered in practice and the methods of eliminating them. The author's conclusion is that the system is one of great value for use in places where trolley lines are excluded, and that the difficulties which have hitherto arisen are all of a kind that can be overcome in the light of the experience which has been obtained in the use of the system in Paris. The paper is illustrated by numerous sectional drawings. [See also Abstracts Nos. 1992 (1899) and 396 (1900).] G. W. DE T.

2184. *The Transition Spiral.* **W. M. Torrance.** (West. Soc. Engin., Journ. 7. pp. 145–163; Discussion, pp. 163–216, April, 1902.)—The author contends that in order to obtain the best possible riding quality for fast trains resort should be had to the use of transition spirals. The correct method of obtaining super-elevation at the end of a curve is to insert between the tangent and the circular curve a transition spiral in which the curvature increases from zero at its tangent end directly with the distance from the end to the curvature of the regular circular curve at its other end. The centrifugal force which renders super-elevation necessary is directly proportional to the curvature at any point. If super-elevation is introduced into the line on the spiral, in exact proportion to the curvature in it, every condition for an easy riding is satisfied. The author does not agree that financially, and from an engineering standpoint, it is difficult to maintain a spiralled curve, as, properly constructed, it will practically maintain itself, whereas, if there is no spiral, the line is certain to require constant attention on the part of the trackmen. The author supports this by contending that there are very few main-line curves which the permanent-way men have not found necessary to "ease off" if the engineer has not come to their aid by giving them spirals. Other salient points of the paper are: (*a*) That it is always possible on an old track to add spirals to the curves by throwing them out so little as to be quite inexpensive; this will be especially true if the spirals are added while other work, such as extensive ballasting or doubling the line, is being done. (*b*) To see that after the spiralled centre line is staked out and the track is being made to conform to it, for line, the ends of the super-elevation run-off are made by the permanent-way men to conform exactly with the ends of the spiral, and that the change from zero at one end to the full super-elevation is obtained proportionately to the distance from the zero end. The discussion brought into prominence the fact that most practical engineers in charge of maintenance declared in favour of spiralling railway curves, although views antagonistic to the principle were freely expressed. The most important were that spirals do not help a moving train to run in a circular direction, as the motion is as much "on tangent" when it has reached a heavy curve direct from tangent as when supposed to be coddled into curvature by a spiral. Further, that lateral elevation is dependent on curvature and *speed*, and that the road most perfectly spiralled for one degree of speed is a bad misfit for all other speeds. The latter objection, however, applies to any curve having lateral elevation, whether spiralled or not. The paper describes various methods for spiralling curves on maintenance work, and is accompanied by useful diagrams and tables. C. E. A.

2185. *Electric Locomotive for Rack and Adhesion Railway.* **M. Gaze.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 600–605, April 26, 1902.)—The author describes a short line which has been constructed for the purposes of a sugar refinery on the Elbe, the steepest incline on which is one of 15 per cent. It is worked partly by adhesion and partly by the Abt rack. The article deals mainly with the mechanical construction of the locomotive and track, and specially notices such details as are connected with the passage from the rack-driven part of the line to the other portion. W. H. S.

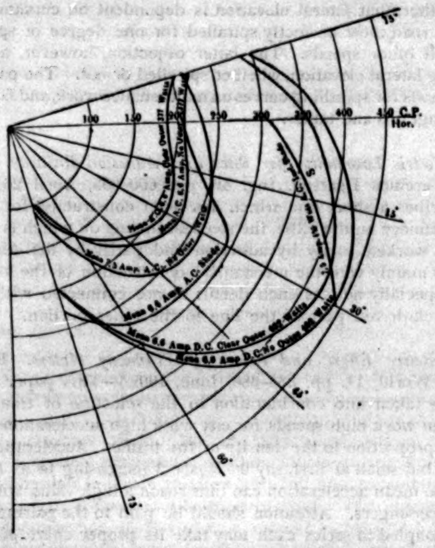
2186. *Tractive Effort and Power of Tramway Motors.* **H. C. King.** (Tram. Rly. World, 11. pp. 383–386, June, 1902.)—This paper discusses the points to be taken into consideration in the selection of tramway motors. For suburban work high speeds, for city work high accelerations are required —higher in proportion to the density of the traffic. Acceleration should not be uniform, but small at first, say 0·5 ft./sec.2 increasing to as high a rate as possible; the mean acceleration can thus reach a high value without discomfort to the passengers. Attention should be paid to the pairing of motors so that when coupled in series each may take its proper share of load without differing in speed from the other. A convenient way of making the pairing test is described. A diagram is given showing graphically (1) tractive effort as a function of weight of car and gradient; (2) the same as a function of weight of car and acceleration; (3) b.h.p. as a function of tractive effort and speed, and by numerical examples the use of the diagram is explained. B. P. S.

ELECTRIC LAMPS AND LIGHTING.

2187. *Photometric Tests of Arc Lamps.* (West. Electn. 30. p. 362, May 24, 1902. Abstract of report presented to the National Electric Light Association at Cincinnati, Ohio, May 21, 1902.)—This is the third report of the Committee. [See also Abstracts Nos. 2347 (1900) and 2044 (1901).] It deals mainly with enclosed arc lamps, and the results are summarised in the appended diagram. The lamps in all cases were run with opalescent inner globes; but, as shown on the diagram, some of the curves were taken with clear outer globes, some with no outer globe, and some with a street shade. The 7·5-ampere alternating-current lamps have a power-factor of 0·88, and take therefore about the same amount of power as the 6·6-ampere direct-current lamp. The power-factor of the 6·6-ampere alternate-current lamp was 0·88. The watts per mean hemispherical c.p. for the different types were as follows:—

D. C. 6·6-ampere op. inner, clear outer	1·31 watts per c.p.
A. C. 6·6-ampere op. inner, clear outer	1·92 watts per c.p.
A. C. 6·6-ampere op. inner, shade	1·48 watts per c.p.

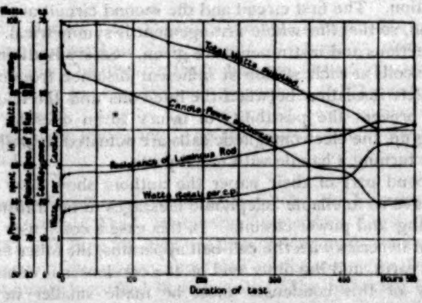
Another diagram gives the light obtained by the expenditure of 450 watts in an arc lamp under varying conditions. The variations considered include those due to direct- and alternating-current, open and enclosed arcs, current large or small, clear and opalescent globes, &c., the current in all cases being inversely proportional to the e.m.f. A further diagram gives the photometric value of an arc lamp plotted as a function of the height of the lamp. For the open arc with a height of 40 ft., the greatest mean illumination is obtained. With the enclosed arc the results are somewhat contradictory; but the maximum mean illumination seems to be obtained with a height of between 25 and 30 ft.



W. H. S.

2188. *Tests of the Nernst Lamp.* **R. P. Hulse.** (Inst. Elect. Engin., Journ. 31. pp. 1180–1196; Discussion, pp. 1196–1199, June, 1902. Paper read before the Birmingham Section, March 19, 1902.)—The following tests were carried out on *continuous* current, the lamps taking 0·9 ampere at 110 volts. All the candle-powers were measured in a horizontal direction with the filament vertical. The current was supplied with a battery of accumulators, and the runs were perfectly continuous. When run at 110 volts on direct-current the average life of three filaments was found to be 473 hours, the c.p. falling from 66 to 20, and the watts per c.p. rising from 1·51 to 3·61. The c.p. falls about 6 per cent. in the first hour of running, but after that the rate of fall is much slower. The appended curves summarise the results of this test.

The cause of breakage in all cases was found to be the fracture of the platinum contact at the positive end of the filament. The author calculates that after 350 hours the lamp has reached the end of its economical life, and therefore its relatively short life is no disadvantage. A further test was made in which the lamps were overrun at a pressure of 116·5 volts. The efficiency at the start in this case was 1·32 watts per c.p., and after 200 hours it was 1·85 watts per c.p., the lamp breaking after 220 hours. The efficiencies were therefore only slightly better than in the preceding case, while the life was rather less than half its preceding amount. When run with constant current of 0·89 ampere, the life was 372 hours, and the watts per c.p. in this test rose from 1·15 to 1·9. The filament becomes crystalline after being in use for some time; it blackens near the negative end, and changes through grey to a faint yellow at the positive end. There is a slight white deposit on the glass globe during the early part of its life, and this is especially noticeable with overrun lamps. Sometimes a faint hissing or singing sound is emitted by the filament, and is accompanied by a fluctuation (usually a diminution) of current, amounting to about 2 per cent. When run without globe the filament is cooled and its resistance increased by about 1 per cent. A new filament, when normally burning, has a specific resistance of 0·7 ohm per cm. cube; after 450 hours it appears to be 1·06 ohm. The automatic switch and the heating coil are reported to work well. The author considers the average efficiency of the Nernst lamp taken throughout its life to be 2·1 watts per c.p., and compares this with an average efficiency of 3·6 watts per c.p. for the ordinary incandescent lamp. Allowing for the shorter life of the Nernst lamp, renewals cost three times as much as in the case of the glow lamp. Therefore assuming 4d. as the cost of a unit, and allowing for the cost of renewals, the Nernst lamp will furnish 1,000 c.p.-hours for 11d., which would cost 15d. with ordinary incandescent lamps.



W. H. S.

REFERENCE.

2189. *The Lighting of Diversey Boulevard, Chicago.* **J. R. Cravath.** (Amer. Electn. 14. pp. 165–166, April, 1902.) L. G.

TELEGRAPHY AND TELEPHONY.

2190. *Telephone Circuits.* **J. Puluj.** (Zeitschr. Elektrotechn., Wien, 19. pp. 281–284, 1901.)—Telephone lines can, as a rule, be effectively protected against injury from lightning by means of fuses, but such fuses do not necessarily afford protection to the operators and subscribers, nor are they a complete guard against stray currents from electric light and power circuits. The author shows that a safe arrangement can be arrived at by making use of inductive coils. The sending circuit contains the microphone, the primary winding of the induction coil, a battery, and an automatic switch actuated by the telephone hook. The receiving circuit contains the secondary winding of the induction coil and the telephone. The third circuit, which is the line circuit, contains two inductive coils, one at the sending and the other at the receiving station. The first circuit and the second circuit are repeated at the second station, so that the whole arrangement is symmetrical. Diagrams of station connections and instruments are given. Safety is attained by placing the inductive coils at each station at sufficient distance from one another to ensure complete insulation between the line-coils and the telephone circuit. In order to prevent the possibility of injury tó an operator or subscriber when ringing up, the electromagnetic calls are actuated by pulling a silk cord instead of by turning a handle with metal parts.

In the second part of their paper the authors show how to modify the arrangements so as to enable telephonic messages to be transmitted through electric-lighting and power circuits. In this case a condenser and fuse-wire are connected in series with the call-bell apparatus, the other end of which is connected to earth, and the other end of the condenser is connected to line. The capacity of this condenser must be made smaller in proportion as the working voltage of the power supply is greater. The authors claim that by carefully selecting the capacity of the condensers the disturbances due to dynamo fluctuations and the like can be reduced or modified so that telephonic transmission is practicable. Arrangements for use with single-phase and three-phase dynamo circuits are also described, showing how they can be adapted to the purposes of telephony. R. A.

2191. *Telephone Conduits.* **Rühl.** (Archiv Post Tele. 7. pp. 213–227, April, 1902.)—This is an account of the methods adopted in Berlin and other German towns for putting in telephone cables under streets, with special reference to economy, durability, convenience of drawing in or out, and provision of space for subsequent increase of business. As regards materials, it is shown that cast-iron compares very badly with cement. References are given to descriptive accounts of the various systems, and dimensions of some of the more important conduits are marked on the figures. Details of comparative costs of some of the Berlin systems are quoted, and other particulars relating to the weight of the blocks, tubes, and plates, together with notes on the comparative rates of construction, are added. R. A.

REFERENCE.

2192. *Telephone Service in the River Plate.* (Electrician, 49. pp. 376–379, June 27, 1902.)—Description and photographs of exchanges and subway work in Buenos Aires. J. E. K.